THE EFFECTS OF NITROGEN/PHOSPHORUS RATIOS ON THE PREDICTION OF CHLOROPHYLL IN PHOSPHORUS-LIMITED LAKES IN CENTRAL ONTARIO

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PREFACE

Relationships between chlorophyll a and total phosphorus (TP) were examined on phosphorus-limited oligotrophic and mesotrophic lakes in central Ontario. Linear regression analysis indicated mostly random associations between chlorophyll a and total P, suggesting a steady state. Chlorophyll a/total P regression models have an inherent inability to predict annual variations for the period 1976 to 1987.

ABSTRACT

The response of mean annual ice-free chlorophyll a in 15 stratified, P-limited oligotrophic and mesotrophic lakes in central Ontario to changes in mean epilimnetic total phosphorus (TP) within a lake was highly variable between years during the period 1976 to 1987. The linear regression coefficient of determination, R^2, using all annual means was only 0.36 (n = 172 lake-years) and within-lake regressions revealed mostly random associations between chlorophyll a and TP, suggesting fluctuations about steady state levels. Nevertheless, by using the long-term average of annual means for each lake, a bivariate linear regression model was developed relating the long-term, average response of chlorophyll a to the long-term, average TP concentration in these lakes (R^2 = 0.78). Annual variation could not be explained by changes in TN/TP. R^2 increased slightly from 0.78 to 0.82 with TN/TP as a second independent variable using long-term averages but remained at 0.78 with 1/TP as a second variable. Reanalysis of published data excluding lakes which were not P-limited showed that TN/TP is of little or no benefit as an independent variable. A minimum of 6 consecutive years of sampling was required to avoid anomalously poor fits (defined as $R^2 < 0.6$) for this set of lakes. Therefore, chlorophyll a/TP regression models should be viewed as steady state models with an inherent inability to predict annual variation.

RÉSUMÉ

Durant la période allant de 1976 à 1987, la réaction de la moyenne annuelle de chlorophylle a, non combinée à la glace, aux changements moyens du phosphore total (TP) de la surface aqueuse d'un lac était très variable dans 15 lacs stratifiés, oligotrophes limités en P et mésotrophes du centre de l'Ontario. En tenant compte de toutes les moyennes annuelles, le coefficient de détermination de la régression linéaire, R^2, était de seulement 0.36 (n = 172 lacs-années) et les régressions à l'intérieur même du lac ont révélé des associations des plus aléatoires entre le chlorophylle a et le TP, suggérant ainsi des fluctuations relatives aux niveaux d'état constant. Néanmoins, en utilisant la moyenne à long terme des moyennes annuelles pour chaque lac, un modèle de régression linéaire à deux variables a été développé afin d'établir un rapport entre la réaction moyenne à long terme du chlorophylle a et la concentration moyenne à long terme du TP de ces lacs (R^2 = 0.78). La variation annuelle ne pouvait pas être expliquée par les changements du TN/TP. Le R^2 a légèrement augmenté de 0.78 à 0.82 avec le TN/TP en tant que deuxième variable indépendante en utilisant les moyennes à long terme mais s'est maintenu à 0.78 avec 1/TP en tant que deuxième variable. Une analyse subséquente des données publiées excluant les lacs qui n'étaient pas limités en P a indiqué que le TN/TP est peu ou pas utile en tant que variable indépendante. Un minimum de 6 années consécutives d'échantillonnage était requis pour éviter des ajustements anormaux (définis comme étant $R^2 < 0.6$) pour cet ensemble de lacs. Par conséquent, les modèles de régression chlorophylle a/TP doivent donc être vus comme des modèles d'état constant, possédant une habilité inhérente pour prédire la variation annuelle.

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INTRODUCTION

A concerted effort has been made during the past two decades to predict the trophic status of lakes based on the response of lakes to total phosphorus (TP) loading and concentration (Vollenweider 1969; Dillon and Rigler 1975). Development of predictive tools has focussed upon steady state models because parameterization of steady state models is limited and because they are readily adaptable as management tools.

Two noteworthy models that have met with some success are those that predict chlorophyll a as a function of TP concentration in P-limited lakes (Dillon and Rigler 1974; Jones and Bachmann 1976; Nicholls and Dillon 1978; Canfield 1983; Prepas and Trew 1983; Riley and Prepas 1985; Dillon et al. 1988) and those that predict TP concentration as a function of annual TP load and flushing characteristics (Vollenweider 1969; Dillon and Rigler 1975; Dillon 1975; Kirchner and Dillon 1975; Larsen and Mercier 1976; Canfield and Bachmann 1981; Frisk et al. 1981; Chapra and Reckhow 1983; Reckhow and Chapra 1983). Together, these models permit dose/response estimates by linking land use activities in the catchment to changes in water quality.

To improve the goodness of fit (i.e., to better explain scatter in some data sets) between chlorophyll a and TP, linear regression analyses have included at times additional independent variables such as total N (Smith 1982; Canfield 1983), total N to total P ratio (TN/TP) (Canfield 1983; Dillon et al. 1988; Prairie et al. 1989) and mean depth (Pridmore et al. 1985). The argument that scatter can result from pooling data sets with different

sampling and analytical methods (Nicholls and Dillon 1978) is typically minimized when large data sets are sought (Smith 1982; Canfield 1983; McCauley et al. 1989; Prairie et al. 1989).

TN/TP has been included as a second independent variable because it is recognized that N is an important factor controlling standing crop in N-limited lakes and that the ratio is an indication of N- or P-limitation. Inclusion of the ratio may, therefore, permit construction of a regression equation which predicts chlorophyll a over a wide range of N- and P-limitation. Trophic response models must then include predictions of TN as well as TP - a major disadvantage. TN/TP has apparently improved goodness of fit even in data sets restricted to P-limited lakes (Dillon et al. 1988). This suggests that chlorophyll a is to some degree affected by TN/TP in P-limited lakes which is inconsistent with Liebig's Law of the Minimum (Odum 1971), laboratory evidence (Ahlgren 1988) and fertilization experiments (Schindler 1980).

We present here a statistical analysis of the relationship between chlorophyll a and TP in 15 P-limited lakes in central Ontario sampled from 1976 to 1987. The role of TN/TP as a factor controlling chlorophyll a is addressed as well as the effect of annual variation on regression goodness of fit.

METHODS

Sampling procedures are described in Dillon et al. (1988) and all analytical methods are described in detail in Ontario Ministry of the Environment (1983). Chlorophyll a was measured in volume-weighted samples representing twice the Secchi depth at least monthly and averaged within each lake for the summer stratification (Chl_{ss}) and ice-free (Chl_{if}) periods, the latter including both spring and fall overturn. Both Chl_{ss} and Chl_{if} were used in the analyses because standing crops during overturn could be important and because published regressions of data from these lakes have used Chl_{ss} (Dillon et al. 1988). TP was measured in volume-weighted epilimnetic, metalimnetic and hypolimnetic samples which were determined from temperature profiles. TP_{ss} refers to the whole-lake TP concentration and TP refers to the epilimnetic TP concentration averaged for the summer stratification period.

Correlation and ordinary least squares regression analyses were performed with PC SAS using annual means as the basic 'unit' parameter. Several regression analyses were performed: (1) chlorophyll a versus TP, chlorophyll a versus TP and 1/TP, and chlorophyll a versus TP and TN/TP using long-term averages for each lake, (2) within-lake regressions of chlorophyll a versus TP using annual data and (3) within-year regressions of chlorophyll a versus TP using annual data. The transformed variable, 1/TP, lacks an a priori causal relationship with chlorophyll a. It was used as a reference for the variable TN/TP because of its similar construct yet arbitrary nature.

When using the average of annual means, 1/TP for each lake was calculated as the reciprocal of long-term average TP and TN/TP was calculated as the average of the annual ratios with each ratio defined as (annual epilimnetic TN)/(annual epilimnetic TP).

RESULTS

Annual summer stratified chlorophyll a (Chl_{ss}), ice-free chlorophyll a (Chl_{if}), epilimnetic TP and TN/TP (by weight) are presented in Table 1 averaged for the period 1976 to 1987. The lakes are oligotrophic to slightly mesotrophic with long-term mean annual TP concentrations ranging from 4.8 to 11.8 μg P L-1 and Chl_{if} ranging from 1.8 to 4.7 $\mu g\ L^{-1}$. Long-term mean epilimnetic TN/TP was greater than 29 for all lakes. Mean ice-free dissolved inorganic N ranged from 73 to 175 $\mu g\ L^{-1}$ (32 $\mu g\ L^{-1}$ in Blue Chalk), hence, the lakes are considered P-limited. Mean depths range from 4.8 m in Gullfeather to 16.7 m in the main basin of Red Chalk.

Chl_{if} and Chl_{ss} were, not surprisingly, similar and highly correlated with pooled averages of all the lakes of 2.9 and 3.0 $\mu g\ L^{-1}$, respectively. The correlation coefficient was 1.0 using averages of annual means.

The correlation between epilimnetic TP and Chl_{if} using average, annual means was slightly higher (0.88) than the correlation between epilimnetic TP and Chl_{ss} (0.86). Correlations between whole-lake TP_{ss} and Chl_{if} and Chl_{ss} were substantially lower with r =

0.60 for both perhaps because the high TP concentrations in bottom waters do not contribute much to primary productivity. Consequently, only epilimnetic TP was used in the following regression analyses.

(1) Long-term Averages

The linear regression coefficient of determination, R^2 (defined as (the sum of squares due to regression)/(total sum of squares corrected for the mean)), for the 12 year data set using the average of the annual mean values for Chl_{ss} versus TP, versus TP and 1/TP, and versus TP and TN/TP were 0.75, 0.75 and 0.78, respectively (Table 2). Slightly higher R^2 values resulted from using mean Chl_{if} values rather than mean Chl_{ss} values for the 12 year period (Table 2, Fig. 1a). Again, use of 1/TP or TN/TP as additional independent variables was of little or no benefit although the addition of TN/TP was significant at an entry level of 0.10.

Logarithmically transforming the data resulted in lower R^2 (Table 2). R^2 for $\log(Chl_{if})$ versus log(TP) was 0.75. Adding log(1/TP) as an additional independent variable was not possible (the model was not full rank) and adding log(TN/TP) increased R^2 to 0.81. Similar results were obtained with $\log(Chl_{ss})$.

Data from 1976 to 1979 were also analyzed for this set of lakes for comparison because Dillon et al. (1988) found, when using data from 1976 to 1979, that goodness of fit improved for Chl_{ss} when TN/TP was included as a second independent variable. Jerry

Lake was excluded because it was not sampled after 1980. R^2 for Chl_{ss} versus TP, versus TP and 1/TP, and versus TP and TN/TP was 0.79, 0.88 and 0.85, respectively (Table 2). R^2 using Chl_{if} was almost identical. The variable 1/TP improved the regression fit better than TN/TP in the 1976-1979 data set whereas 1/TP had no effect in the 1976-1987 data set. It is suspected, therefore, that the small increase in goodness of fit observed in the 1976-1979 and 1976-1987 data sets observed with TN/TP was due to 'forcing' as a result of including additional variables.

(2) Short-term Averages

The effects of annual variation on the chlorophyll a - TP relationship can be seen by using each lake-year as a separate observation (Fig. 1b). R^2 for Chl_{if} versus TP and $\log(Chl_{if})$ versus $\log(TP)$ were only 0.36 and 0.32, respectively, (n=172 lake-years). Scatter due to annual variation was not explained by the addition of secondary independent variables. R^2 for Chl_{if} versus TP and 1/TP, and versus TP and TN/TP were 0.37 and 0.39, respectively.

The effects of annual variation are also seen in within-lake regressions of Chl_{if} versus TP in which the mean R^2 was 0.13, ranging from 0.001 (Harp Lake) to 0.52 (Crosson Lake) (Fig. 2). The relationship in Crosson Lake, however, was inverse. Temporal variation in Chl_{if} in Harp and Crosson Lakes was similar during some years, particularly 1979 to 1983 whereas the temporal responses of epilimnetic TP were not as similar (Fig. 3).

The effects of annual variation were also investigated by performing within-year(s) analyses. R^2 for within-year (one year) regressions ranged from 0.11 (in 1986) to 0.79 (in 1978) (Table 3). A minimum of 6 consecutive years was required to avoid anomalously poor fits (defined as $R^2 < 0.6$) for this set of lakes because of one very low within-year R^2 in 1986. Even when the 1986 and 1987 years were excluded from the analyses, a minimum of 4 years consecutive sampling was necessary to ensure that $R^2 > 0.6$ and 5 years to ensure that $R^2 > 0.7$.

DISCUSSION

There was little improvement in R^2 when TN/TP was included as a secondary independent variable in the regression analyses of long-term Chl_{if} versus TP in the 1976-1987 data set (4% increase; Table 2). In the 1976-1979 data set, R^2 was higher with 1/TP than with TN/TP suggesting that mathematical/statistical 'forcing' is as likely an explanation for the slight increase in goodness of fit with TN/TP as is some causal explanation. A causal connection between TN/TP and chlorophyll a in P-limited lakes is a weak one at best.

Re-analysis of published data yields similar observations. Using average, summer values for stratified prairie lakes (Prepas and Trew 1983) with TN/TP $\geq$ 20, R^2 for chlorophyll a versus TP, versus TP and 1/TP, and versus TP and TN/TP was 0.73, 0.79

and 0.73, respectively. Reanalysis of data presented by Smith (1979) for 24 basin-years with TN/TP ratios $\geq$ 20 yielded R^2 values for chlorophyll a versus TP, versus TP and 1/TP, and versus TP and TN/TP of 0.71, 0.75 and 0.71, respectively. For 8 stations with TN/TP $\leq$ 15 (7 were from one reservoir), R^2 was 0.56, 0.58 and 0.68, respectively (Smith 1979).

Pridmore et al. (1985) analyzed the log/log relationship between chlorophyll a and TP in 21 New Zealand lakes and found that R^2 increased from 0.71 to 0.80 when the logarithm of mean depth was included. They subsequently recommended different regressions for lakes with mean depth less than or greater than 11 m. In re-analyzing their data, however, R^2 for untransformed chlorophyll a versus untransformed TP was 0.82, increasing slightly to 0.83 when mean depth was included as an independent variable. Hence, logarithmic transformations increased the variance which was subsequently attributed to a mean depth effect. Addition of TN/TP increased R^2 from 0.82 to 0.88 whereas 1/TP had no effect on R^2. When lakes with TN/TP < 20 were excluded, R^2 values for chlorophyll a versus TP, versus TP and 1/TP, and versus TP and TN/TP were identical at 0.94.

Pooling data for P-limited inland lakes (TN/TP $\geq$ 20) from Prepas and Trew (1983), Pridmore et al. (1985) and the central Ontario lakes (Table 1), R^2 for chlorophyll a versus TP, versus TP and 1/TP, and versus TP and TN/TP was 0.79, 0.84 and 0.79 (n = 42), respectively. Furthermore, logarithmically transforming the data lowered the goodness of

fit with R^2 for log(chlorophyll a) versus log(TP), and versus log(TP) and log(TN/TP) of 0.54 and 0.58, respectively.

Clearly, analysis of central Ontario and published data shows that TN/TP is of little or no use as a second independent variable in linear regression models of chlorophyll a versus TP in P-limited lakes. Fertilization studies provide corroborative experimental evidence by showing that chlorophyll increases are not affected by changes in loading TN/TP (Schindler 1980) or by N additions to P-limited enclosures (Prepas and Trimbee 1988).

There is laboratory evidence that dual limitation occurs in the transition zone between N- and P-limitation and therefore both N and P will affect phytoplankton abundance over a somewhat varying TN/TP range (the interactive model in growth kinetic studies) (Ahlgren 1988). However, beyond the transition zone, TN/TP is not expected to affect abundance. The effect of TN/TP on standing crop could be resolved in situ experimentally by a series of N additions to systems with a low to intermediate background TN/TP extending the TN/TP ratio well into the strictly P-limited range.

The concept of attempting to predict chlorophyll as a function of TP in systems whose productivity is clearly not P-limited is questionable. Although the shapes of published chlorophyll/TP curves are somewhat consistent, it does not follow that TP can or should be used as a major predictor variable when productivity is clearly not limited by TP (McCauley et al. 1989; Prairie et al. 1989, and others). When excess P occurs, either

as luxury consumption or as high extracellular concentrations, quantitative relationships between chlorophyll and TP will weaken resulting in increased scatter in chlorophyll/TP curves. The empirical approach to predicting chlorophyll has stressed TP under all limiting conditions, however, this approach is flawed and should be viewed with caution.

The response of ice-free chlorophyll a to changes in epilimnetic TP between years within a lake was highly variable and appeared random (Figs. 1b and 2). Indeed, R^2 using all annual data was only 0.36 suggesting that annual differences in factors such as solar radiation, wind stress, water temperature, grazing rates, etc. mitigate the response of phytoplankton communities to phosphorus. Annual variation could not be explained by changes in TN/TP.

Nevertheless, TP concentration clearly sets limits to growth about which other factors operate, i.e. fluctuations occur about an average, steady state level. By using long-term means for each lake, a simple linear model was developed capable of predicting the long-term average response of chlorophyll a to the long-term average epilimnetic TP concentration in oligotrophic and mesotrophic lakes with a relatively high $R^2 = 0.78$. The wide range in standing crops produced at a given TP concentration reported in the literature (McCauley et al. 1989) is undoubtedly due in part to annual variation - a feature of short-term data collection.

The response of chlorophyll a to TP within the study lakes was due to a combination of regional and site-specific factors (Goldman et al. 1989). Strong regional

influences affecting lakes were evident in the responses of Crosson and Harp Lakes from 1979 to 1983 whereas during other years, especially 1976 and 1986, lake-specific factors appeared dominant (Fig. 3).

The extent to which lake-specific factors dominate may affect the extent of deviation from the regression equation in Figure 1a. For example, Crosson Lake appears to deviate the most with a lower Chl_{if} than expected given its mean TP of 9.1 $\mu g\ L^{-1}$. R^2 for Chl_{if} versus TP excluding Crosson was 0.89 compared to 0.78 using all lakes. The low standing crop in Crosson Lake may have been due to a higher turnover rate. Alternatively, TP may not be a good predictor of Chl_{if} in Crosson if significant quantities of biologically unavailable P are present. Perhaps goodness of fit could be improved using a chemical surrogate for biologically available P instead of TP (Butkus et al. 1988).

Reliable prediction of the long-term average response of chlorophyll a to epilimnetic TP in our study lakes was dependent upon an extensive sampling program involving frequent sampling during the ice-free season over at least 6 consecutive years. It was found that reliable prediction of average long-term TP export from 32 forested stream catchments also required about 6 consecutive years of sampling (unpublished data). Therefore, chlorophyll a/TP regression models based on surveys of P-limited lakes should be viewed as steady state models with an inherent inability to predict annual variation. If short-term means are used (less than 6 years), goodness of fit may or may not be adequate. Long-term averages will ensure a higher goodness of fit. Although use of

annual observations can reduce predictability over limited TP ranges, predictability will be less affected when large TP ranges are involved.

It should be noted that chlorophyll/TP models sometimes employ epilimnetic TP concentration whereas TP concentration/loading models (Vollenweider 1969; Dillon and Rigler 1974) employ whole-lake TP concentration. It should not be assumed that epilimnetic and whole-lake TP are similar. Average annual epilimnetic TP concentrations were less than whole-lake TP concentrations, ranging from 42% in Glen Lake to 93% in Bigwind Lake. Therefore, whole-lake TP must be converted into epilimnetic TP in order to link models employing the two types of TP.

Ideally, a sound management policy for P-limited lakes, based on the relationship between chlorophyll a and TP, should be derived from data obtained from a multi-year, regional study using consistent methodology and excluding lakes which are not strictly P-limited. Meeting these criteria will make it unnecessary to employ additional independent variables to improve goodness of fit, such as mean depth or TN/TP, and may make it unnecessary to transform data logarithmically. Meeting these criteria will, therefore, simplify modelling requirements.

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Table 1. Average of mean annual summer stratified and ice-free chlorophyll a, epilimnetic TP and TN/TP (by weight) for the period 1976 to 1987. Standard deviations are in brackets. Units are $\mu g\ L^{-1}$. ss - summer stratification, if - ice-free, n=12 years for each lake except Red Chalk East (8) and Glen (11 for TP and TN/TP, 9 for Chl_{if}).

Lake	Chl_{ss}	Chl_{if}	TP	TN/TP
Blue Chalk	1.9 (0.2)	1.9 (0.2)	5.0 (0.6)	35.6 (5.9)
Chub	3.4 (1.1)	3.2 (1.1)	8.4 (1.2)	33.4 (4.9)
Crosson	2.8 (0.7)	2.6 (0.7)	9.1 (0.6)	30.7 (4.6)
Dickie	4.8 (1.0)	4.7 (1.3)	10.7 (2.1)	29.3 (7.7)
Harp	3.5 (0.7)	3.2 (0.5)	6.7 (0.7)	38.6 (6.2)
Red Chalk Main	2.3 (0.4)	2.1 (0.3)	4.8 (0.9)	45.6 (10.2)
Red Chalk East	2.8 (0.3)	2.6 (0.2)	4.8 (0.4)	48.1 (10.8)
Basshaunt	2.6 (1.0)	2.6 (1.0)	6.5 (0.9)	43.8 (8.9)
Bigwind	3.2 (1.0)	3.0 (0.8)	6.8 (0.6)	38.1 (6.8)
Buck	2.5 (0.5)	2.5 (0.6)	5.7 (0.6)	44.8 (7.8)
Glen	3.6 (1.7)	3.5 (1.4)	8.1 (1.1)	39.9 (7.0)
Gullfeather	4.6 (0.7)	4.4 (0.7)	11.8 (1.4)	29.0 (9.8)
Little Clear	2.9 (0.6)	2.8 (0.7)	6.3 (1.2)	40.4 (8.2)
Solitaire	1.9 (0.3)	1.8 (0.3)	5.0 (0.8)	43.4 (7.1)
Walker	2.9 (0.9)	2.7 (0.9)	5.8 (0.6)	48.3 (6.5)

Table 2. R^2 for linear regression of chlorophyll *a* versus epilimnetic TP, versus TP and 1/TP, and versus TP and TN/TP (by weight) using untransformed and logarithmically transformed data. Annual means for each of the 15 lakes were averaged for the two periods 1976-79 and 1976-87. ss - summer stratification, if - ice-free.

Independent Variables	1976-79		1976-87	
	Chl_{ss}	Chl_{if}	Chl_{ss}	Chl_{if}
TP	0.79	0.79	0.75	0.78
TP, 1/TP	0.88	0.87	0.75	0.78
TP, TN/TP	0.85	0.85	0.78	0.82
1976-1987:			log(Chlss)	$\log(Chl_{if})$
log(TP)			0.71	0.75
log(TP), log(TN/TP)			0.76	0.81

Table 3. R^2 range for linear regression of ice-free chlorophyll a versus epilimnetic TP using running averages of annual means for the period 1976-1987.

No. consecutive years	R^2 Range	n
1	0.11 - 0.79	12
2	0.29 - 0.80	11
3	0.35 - 0.80	10
4	0.50 - 0.79	9
5	0.54 - 0.82	8
6	0.63 - 0.77	7
7	0.65 - 0.80	6
12	0.78	1

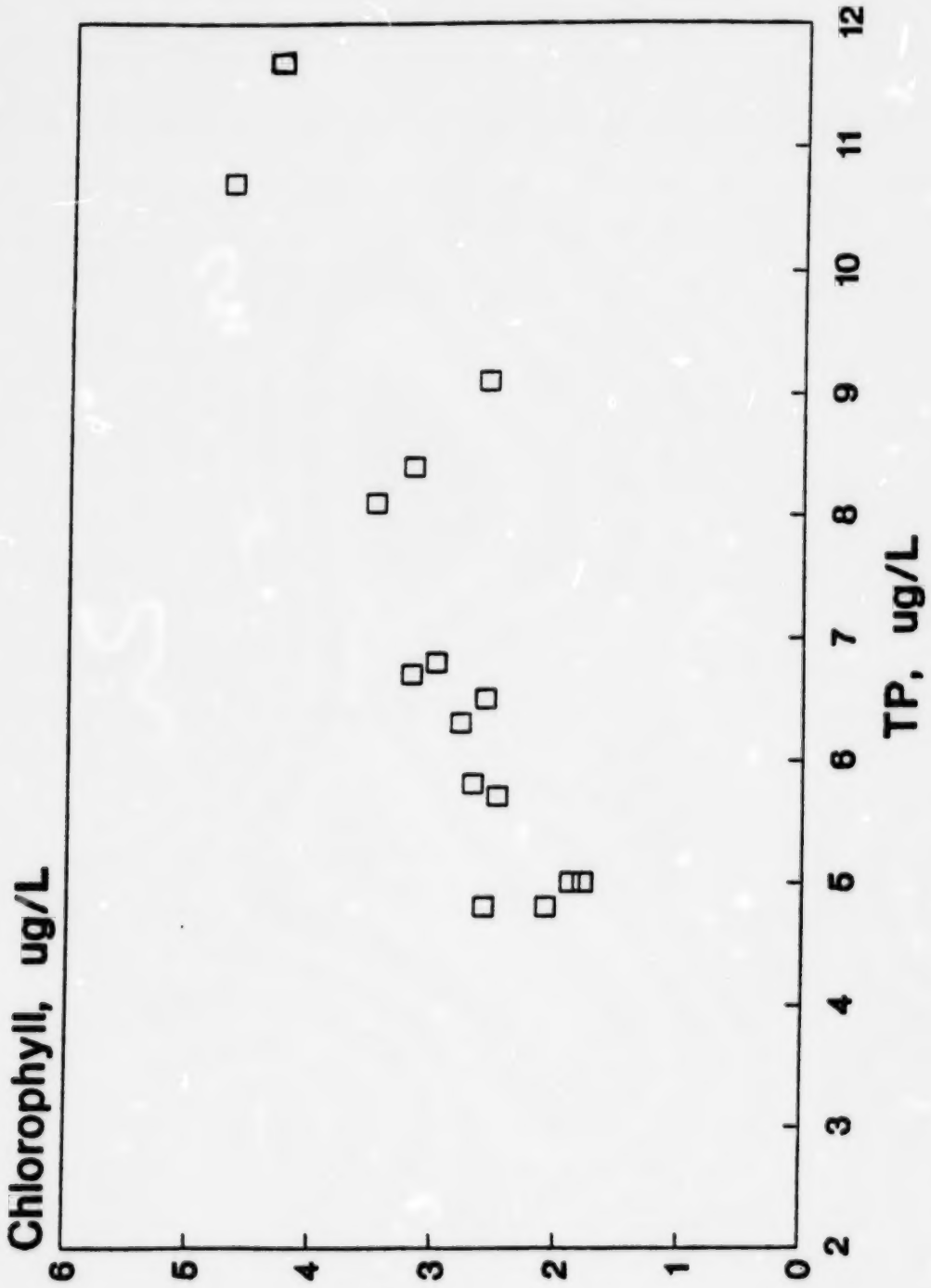

Figure 1(a). Ice-free chlorophyll a versus epilimnetic TP for 15 P-limited lakes in central Ontario for the 12 year period 1976-1987. Average of annual means. The regression equation is Chl_{if} = 0.332 TP + 0.571 (n = 15, R^2 = 0.78, slope SE = 0.049 and the intercept SE = 0.358).

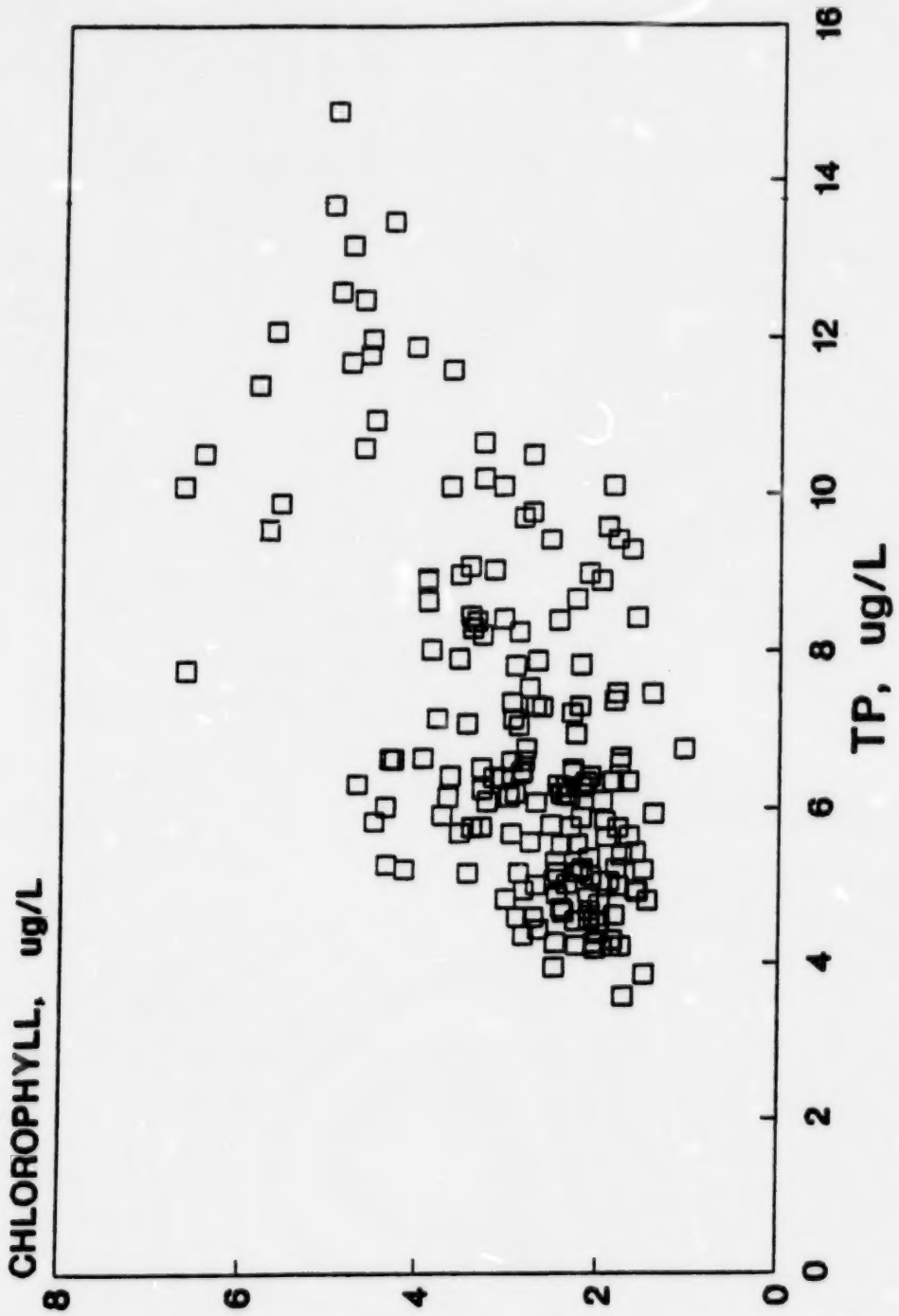

Figure 1(b). Ice-free chlorophyll a versus epilimnetic TP for 15 P-limited lakes in central Ontario for the 12 year period 1976-1987. Annual means (n = 172 lake-years, R^2 = 0.36).

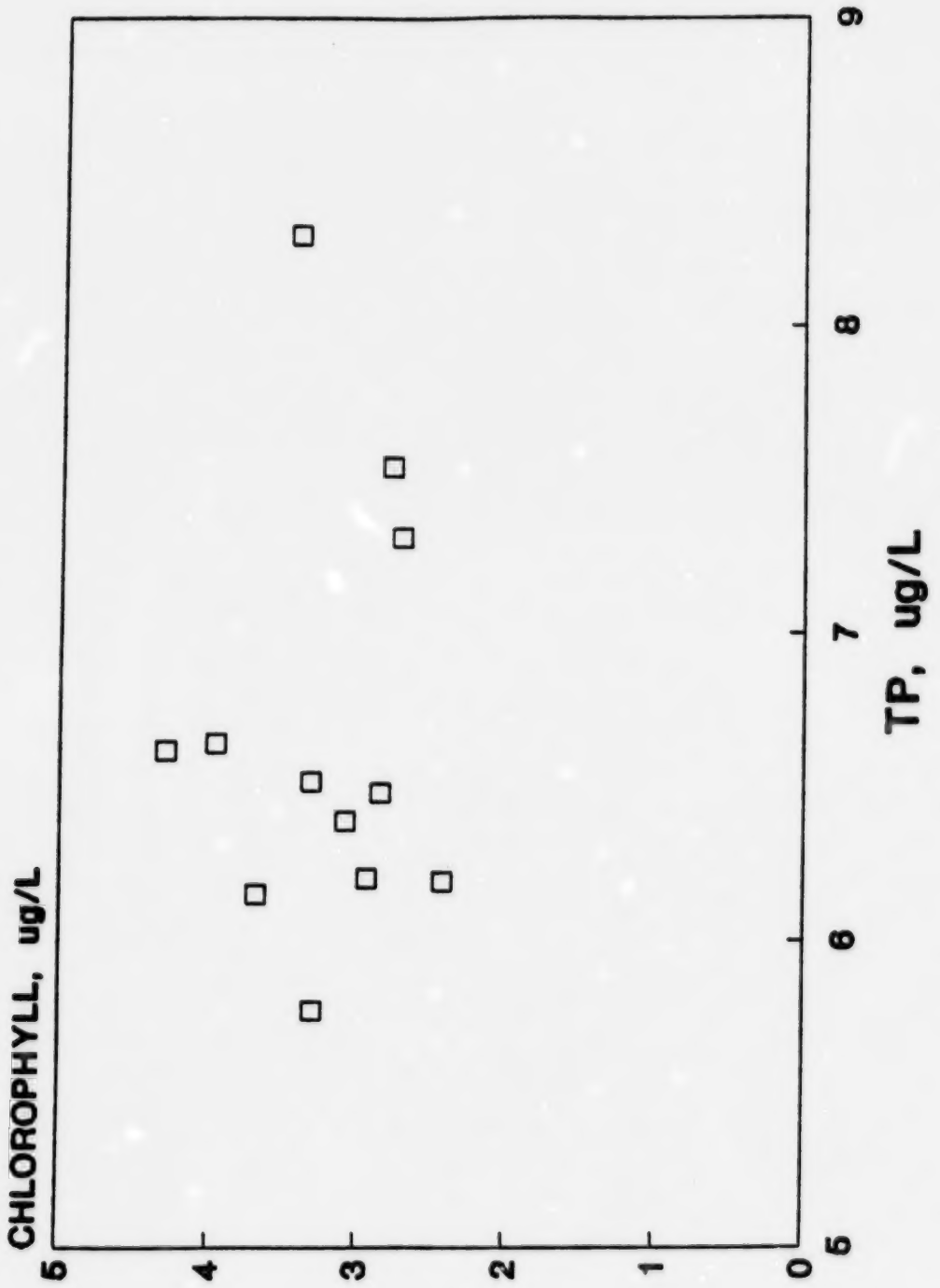

Figure 2(a). Annual ice-free chlorophyll a versus epilimnetic TP for Harp Lake 1976 - 1987.

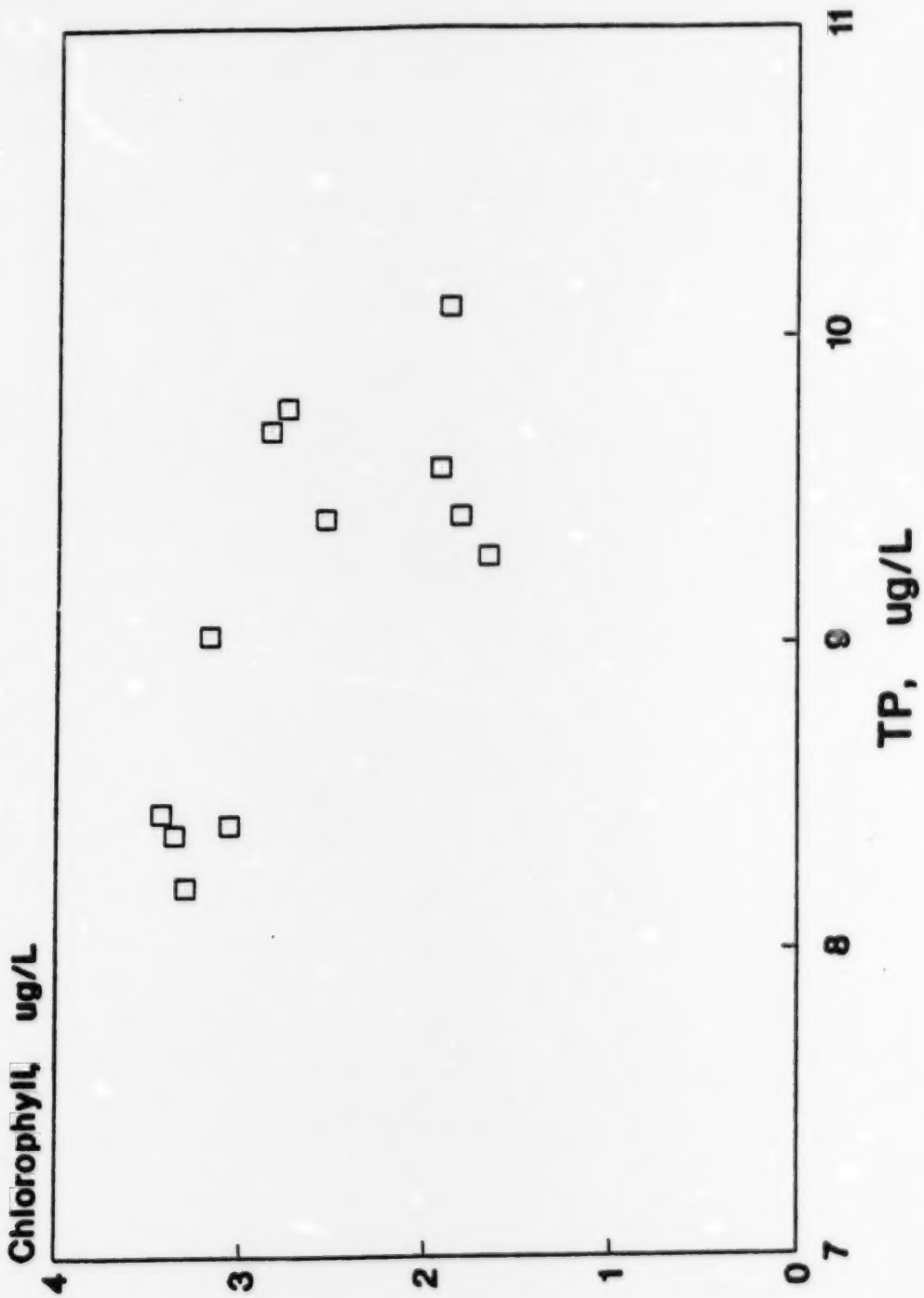

Figure 2(b). Annual ice-free chlorophyll a versus epilimnetic TP for Crosson Lake, 1976 - 1987.

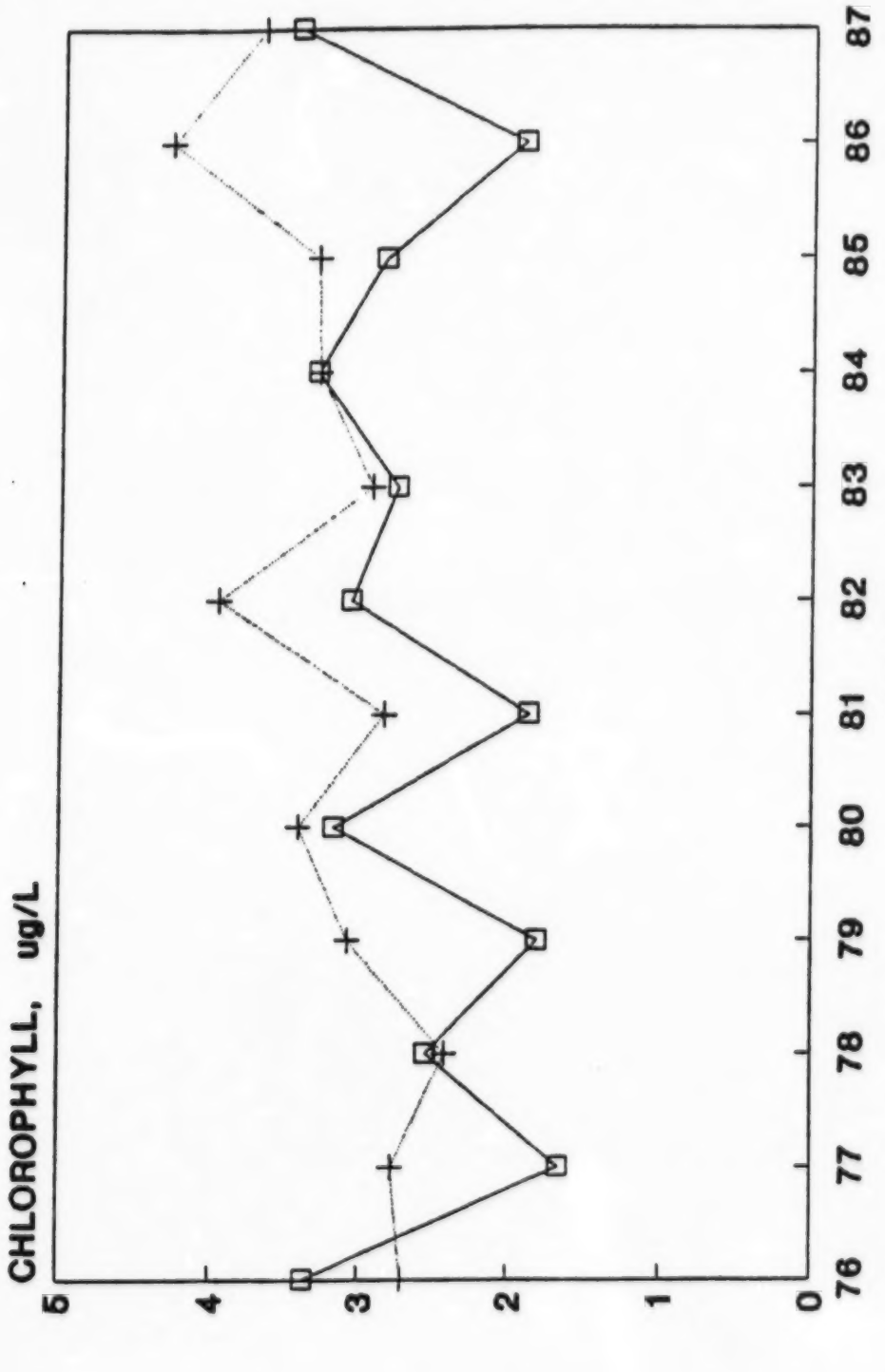

Figure 3(a). Temporal responses of annual ice-free chlorophyll a in Harp and Crosson Lakes from 1976 to 1987.

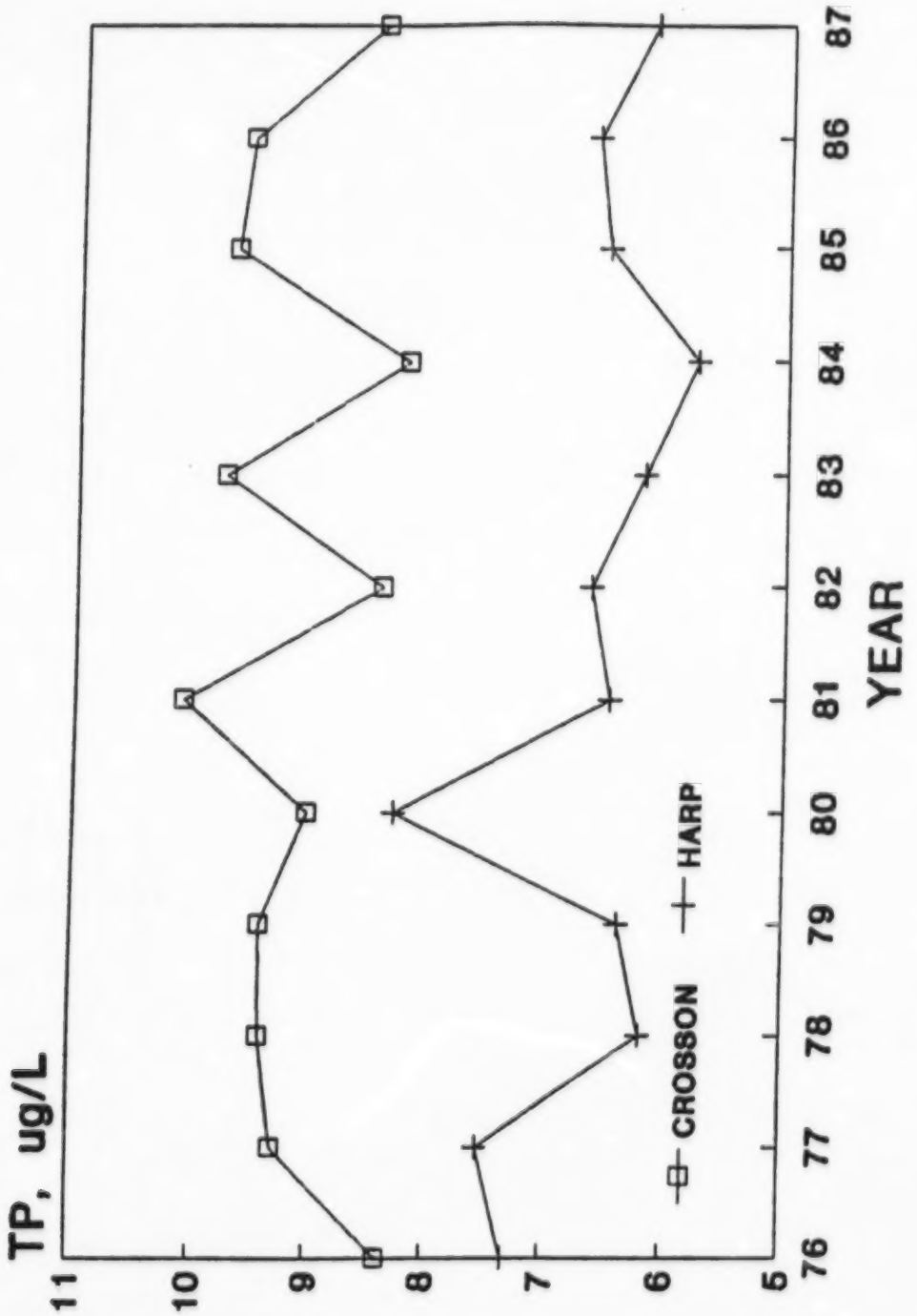

Figure 3(b). Temporal responses of annual ice-free epilimnetic TP in Harp and Crosson Lakes from 1976 to 1987.

APPENDIX

DATA TABLES

Definition of Terms:

CHL - total chlorophyll a, μg/L

TP - total phosphorus, μg/L

NO_3 - nitrate, μg/L

NH_4 - ammonium, μg/L

TON - total organic nitrogen (TKN-NH_4), μg/L

TN - total nitrogen (TKN+NO_3), μg/L

SD - Secchi depth, m

DOC - dissolved organic carbon, mg/L

Subscripts:

ss - mean whole-lake concentration during summer stratification

if - mean whole-lake concentration during the ice-free period

so - whole-lake concentration during spring overturn

fo - whole-lake concentration during fall overturn

an - mean annual whole-lake concentration

epi - mean epilimnetic concentration during summer stratification

Table A1. Chlorophyll, TP, NO_3 and NH_4 concentrations in Basshaunt Lake during 1976/77 - 1987/88.

YEAR	CHLss	CHLif	CHLso	CHLfo	CHLan	TPss	TPif	TPepi	TPso	TPfo	TPan
76.77	2.13	2.13	1.57	.	1.75	10.60	8.93	8.98	7.30	.	9.54
77.78	1.00	1.07	.	1.20	1.00	7.11	7.17	6.75	.	7.30	8.44
78.79	1.80	1.78	1.80	1.60	1.70	6.79	6.84	6.56	6.65	7.30	7.21
79.80	2.32	2.29	2.65	1.40	3.13	7.46	7.67	6.50	8.30	7.45	7.01
80.81	2.86	2.90	.	3.10	2.28	7.88	7.85	7.05	4.70	7.70	7.38
81.82	2.22	2.10	0.80	2.80	2.27	7.02	7.05	6.41	7.17	7.10	7.01
82.83	2.58	2.32	1.30	.	2.74	7.14	7.07	6.16	6.83	.	7.83
83.84	4.50	4.50	3.40	.	4.45	6.42	7.46	5.84	10.60	.	6.76
84.85	2.30	2.53	3.20	.	2.30	6.57	6.57	5.79	7.77	.	6.26
85.86	2.83	2.83	.	.	2.98	6.83	6.83	6.60	.	.	6.70
86.87	4.38	4.38	.	.	3.67	6.81	6.81	6.03	.	.	7.10
87.88	2.22	2.31	2.90	.	2.50	6.26	6.55	5.76	8.30	.	6.26

YEAR	NO_3ss	NO_3if	NO_3epi	NO_3so	NO_3fo	NO_3an	NH_4ss	NH_4if	NH_4epi	NH_4so	NH_4fo	NH_4an
76.77	87.09	101.00	3.50	155.00	.	66.20	12.44	12.70	7.60	.	.	26.10
77.78	43.38	49.00	15.00	.	60.00	92.80	14.39	36.90	12.40	.	82.00	30.10
78.79	108.26	108.00	53.00	145.00	70.00	103.00	18.98	21.40	16.00	13.00	42.00	29.00
79.80	60.99	84.30	15.00	127.50	85.00	87.40	18.01	23.30	11.30	24.00	43.00	18.40
80.81	100.18	95.70	48.30	.	80.00	102.00	11.82	14.10	5.67	.	21.00	26.10
81.82	96.64	101.00	35.00	155.00	65.00	105.00	11.63	14.00	8.20	36.00	3.00	6.43
82.83	79.23	106.00	14.80	210.00	.	88.10	7.31	7.38	2.00	7.00	.	9.58
83.84	57.59	77.40	22.50	123.00	.	72.90	14.86	19.00	11.00	18.00	.	16.50
84.85	56.34	66.10	9.75	105.00	.	56.30	3.19	4.20	2.00	8.00	.	3.26
85.86	86.06	86.06	30.33	.	.	98.70	8.36	8.36	6.33	.	.	8.79
86.87	116.09	116.09	55.00	.	.	119.49	10.83	10.83	7.00	.	.	10.69
87.88	110.51	120.86	47.00	183.00	.	125.45	10.79	10.11	7.50	6.00	.	11.65

Table A2. TON, TN, Secchi and DOC concentrations in Basshaunt Lake during 1976/77 - 1987/88.

YEAR	TONss	TONif	TONEPI	TONso	TONfo	TONan	TNss	TNif	TNepi	TNso	TNfo	TNan
76.77	235.74	238.30	237.40	.	.	214.90	335.27	352.00	248.50	425.00	.	307.20
77.78	163.56	168.10	155.60	.	178.00	149.90	221.33	254.00	183.00	.	320.00	272.80
78.79	283.46	270.60	290.00	142.00	333.00	306.00	410.70	400.00	359.00	300.00	445.00	438.00
79.80	250.67	265.70	246.70	306.00	269.00	278.60	329.67	373.30	273.00	457.50	397.00	384.40
80.81	280.95	280.90	276.33	.	284.00	261.90	392.95	390.70	330.30	.	385.00	390.00
81.82	245.10	250.00	248.80	259.00	267.00	245.57	353.37	365.00	292.00	450.00	335.00	357.00
82.83	230.82	227.62	232.00	213.00	.	233.42	317.35	341.00	248.80	430.00	.	331.10
83.84	221.36	220.00	227.00	242.00	.	223.50	293.81	316.40	260.50	383.00	.	312.90
84.85	253.33	253.80	266.00	257.00	.	253.74	312.86	324.10	277.75	370.00	.	313.30
85.86	234.53	234.53	245.33	.	.	235.87	328.95	328.95	282.00	.	.	343.36
86.87	250.91	250.91	265.00	.	.	243.26	377.82	377.82	327.00	.	.	373.44
87.88	241.04	238.61	240.83	224.00	.	243.07	362.34	369.58	295.33	413.00	.	380.18

YEAR	SDss	SDif	SDso	SDfo	DOCss	DOCif	DOCepi	DOCso	DOCfo	DOCan
76.77	5.33	5.33	5.20	.	.	.	.	.	.	.
77.78	5.90	5.47	.	4.60	.	.	.	.	.	.
78.79	4.82	4.54	2.80	4.60	4.35	4.35	4.55	.	.	4.29
79.80	4.06	4.13	5.00	2.70	4.58	4.45	4.98	4.00	4.70	4.55
80.81	4.02	3.94	.	3.50	4.73	4.74	5.00	.	4.80	4.58
81.82	4.30	4.17	4.00	3.70	4.30	4.30	4.50	4.00	4.60	4.14
82.83	4.30	4.34	4.50	.	3.80	3.64	4.05	3.00	.	3.76
83.84	4.10	4.10	3.00	.	4.18	4.04	4.40	3.60	.	4.14
84.85	4.00	4.04	4.20	.	4.08	4.08	4.38	4.00	.	4.10
85.86	3.97	3.97	.	.	4.28	4.28	4.47	.	.	4.26
86.87	3.58	3.58	.	.	4.17	4.17	4.52	.	.	4.01
87.88	4.72	4.61	4.00	.	4.02	3.96	4.12	3.60	.	3.98

Table A3. Chlorophyll, TP, NO_3 and NH_4 concentrations in Bigwind Lake during 1976/77 - 1987/88.

YEAR	CHLss	CHLif	CHLso	CHLfo	CHLan	TPss	TPif	TPepi	TPso	TPfo	TPan
76.77	2.02	1.84	1.00	1.00	1.81	7.05	7.04	7.37	7.00	.	7.43
77.78	2.82	2.64	2.10	4.40	2.12	8.34	8.38	7.29	8.45	.	7.78
78.79	3.15	2.94	1.70	3.00	2.38	8.34	8.23	7.62	7.90	.	8.45
79.80	2.82	2.46	1.10	2.00	2.23	6.57	7.13	6.30	10.80	6.25	6.54
80.81	2.96	2.96	.	.	2.69	7.77	7.77	7.14	.	.	7.14
81.82	2.38	2.30	0.90	3.30	2.17	6.90	6.80	6.46	6.60	6.47	6.82
82.83	2.62	2.36	0.80	.	2.69	6.83	6.75	6.28	6.25	.	7.08
83.84	3.12	3.30	4.20	.	3.40	6.71	7.06	6.25	8.80	.	7.00
84.85	3.47	3.47	.	.	3.26	7.53	7.53	7.08	.	.	7.37
85.86	4.83	4.34	1.40	.	4.17	7.30	7.31	6.64	7.37	.	6.75
86.87	5.33	4.70	0.90	.	4.84	6.94	6.57	6.32	5.45	.	7.40
87.88	2.85	2.69	1.70	.	2.68	6.88	7.20	6.08	9.15	.	6.88

YEAR	NO_3ss	NO_3if	NO_3epi	NO_3so	NO_3fo	NO_3an	NH_4ss	NH_4if	NH_4epi	NH_4so	NH_4fo	NH_4an
76.77	35.00	54.50	6.43	105.00	.	43.40	14.61	15.30	11.30	.	.	18.10
77.78	71.09	71.80	10.80	70.00	.	99.40	19.18	20.70	15.70	27.10	.	19.20
78.79	137.48	143.00	52.50	175.00	.	145.00	22.20	22.20	24.20	22.00	.	20.60
79.80	88.70	105.00	40.00	180.00	110.00	115.00	13.75	12.70	10.90	7.00	13.00	16.40
80.81	102.79	103.00	58.80	.	.	100.00	7.90	7.90	7.75	.	.	9.32
81.82	105.11	108.00	55.00	145.00	65.00	107.00	14.90	11.10	13.20	2.00	.00	12.20
82.83	71.15	81.50	9.67	140.00	.	83.20	3.91	4.17	3.00	5.00	.	4.74
83.84	74.61	82.40	34.20	120.00	.	65.10	9.06	7.88	6.60	2.00	.	8.31
84.85	59.18	59.20	9.50	.	.	57.90	8.82	8.86	6.67	.	.	9.04
85.86	74.73	84.78	12.80	135.00	.	94.40	9.10	7.75	4.40	1.00	.	7.91
86.87	91.90	102.34	28.00	165.00	.	96.58	6.60	6.08	5.50	3.00	.	7.97
87.88	79.77	88.23	21.00	139.00	.	85.35	7.55	8.33	5.83	13.00	.	7.15

Table A4. TON, TN, Secchi and DOC concentrations in Bigwind Lake during 1976/77 - 1987/88.

YEAR	TONss	TONif	TONEPI	TONso	TONfo	TONan	TNss	TNif	TNepi	TNso	TNfo	TNan
76.77	181.45	184.70	187.70	.	.	172.90	231.06	254.50	205.43	325.00	.	234.40
77.78	221.88	197.30	240.30	120.40	.	220.80	312.15	289.80	266.80	217.50	.	339.40
78.79	230.05	246.80	257.80	298.00	.	233.40	389.73	412.00	334.50	495.00	.	399.00
79.80	236.10	240.30	235.10	223.00	277.00	249.60	330.55	358.00	286.00	410.00	400.00	381.00
80.81	272.75	273.10	296.25	.	.	264.68	383.44	384.00	362.80	.	.	374.00
81.82	223.09	218.90	227.80	208.00	209.00	219.80	343.10	338.00	296.00	355.00	295.00	339.00
82.83	192.39	196.83	193.00	225.00	.	189.26	267.45	282.50	205.67	370.00	.	277.20
83.84	172.37	174.12	181.40	183.00	.	171.69	256.04	264.40	222.20	305.00	.	245.10
84.85	204.12	204.14	211.33	.	.	209.96	272.12	272.20	227.50	.	.	276.90
85.86	194.01	191.51	203.60	179.00	.	197.98	277.84	284.03	220.80	315.00	.	300.29
86.87	201.04	206.17	216.17	237.00	.	200.12	299.54	314.60	249.67	405.00	.	304.67
87.88	179.23	180.34	182.50	187.00	.	184.93	266.55	276.90	209.33	339.00	.	277.42

YEAR	SDss	SDif	SDso	SDfo	DOCss	DOCif	DOCepi	DOCso	DOCfo	DOCan
76.77	6.64	6.44	4.90	.	.	.	.	.	.	.
77.78	4.47	4.78	5.70	4.56	.	.	.	.	.	.
78.79	3.68	3.96	4.80	4.10	3.34	3.34	3.60	.	.	3.42
79.80	4.78	4.87	5.60	4.60	3.24	3.30	3.42	3.70	3.20	3.31
80.81	4.29	4.29	.	.	3.22	3.22	3.49	.	.	3.20
81.82	5.14	5.04	6.00	3.60	3.25	3.29	3.34	3.30	3.50	3.22
82.83	4.97	5.19	6.50	.	3.07	3.05	3.23	2.90	.	3.02
83.84	4.24	4.18	3.90	.	3.00	3.00	3.10	3.00	.	3.05
84.85	4.45	4.45	.	.	3.14	3.14	3.50	.	.	3.17
85.86	4.33	4.24	3.70	.	3.00	3.03	3.20	3.20	.	3.01
86.87	4.28	4.65	6.50	.	3.17	3.15	3.38	3.00	.	3.12
87.88	5.20	5.03	4.00	.	3.17	3.13	3.32	2.90	.	3.20

Table A5. Chlorophyll, TP, NO_3 and NH_4 concentrations in Blue Chalk Lake during 1976/77-1987/88.

YEAR	CHLss	CHLif	CHLso	CHLfo	CHLan	TPss	TPif	TPepi	TPso	TPfo	TPan
76.77	1.91	1.92	1.80	2.00	1.69	7.93	7.84	5.63	4.00	10.20	7.52
77.78	1.88	1.85	0.70	2.10	1.69	7.88	7.76	6.34	5.60	6.60	7.77
78.79	1.68	1.67	0.70	2.50	1.64	6.98	7.00	5.64	6.36	8.05	6.77
79.80	1.87	1.89	1.50	2.70	2.26	6.47	6.52	5.06	.	7.55	6.25
80.81	2.14	2.11	2.00	1.50	1.92	7.13	7.03	4.85	6.55	5.30	6.74
81.82	2.05	2.10	1.65	4.00	1.83	6.17	6.23	4.56	6.30	7.37	6.06
82.83	1.62	1.58	0.70	1.80	1.63	6.90	6.82	4.92	5.91	6.77	6.90
83.84	1.73	1.81	1.90	2.60	1.47	6.81	6.77	5.22	6.97	5.90	6.01
84.85	2.16	1.99	0.95	2.10	1.74	6.26	6.15	4.52	5.75	5.60	5.83
85.86	2.11	1.99	0.60	.	1.74	4.55	4.60	4.77	5.20	.	4.59
86.87	2.03	1.76	0.80	2.00	1.80	4.20	4.45	4.22	.	6.30	4.79
87.88	2.09	2.03	1.00	2.70	1.74	4.75	4.89	4.19	5.25	5.70	6.47

EAR	NO_3ss	NO_3if	NO_3epi	NO_3so	NO_3fo	NO_3an	NH_4ss	NH_4if	NH_4epi	NH_4so	NH_4fo	NH_4an
76.77	16.8L	19.20	7.90	80.00	5.00L	16.80	14.60	14.80	6.58	.	17.60	17.60
77.78	12.9L	13.90	8.15	50.00	5.00	12.30	23.60	23.90	12.80	29.00	27.00	27.70
78.79	15.5L	15.00	7.75	.	5.00	22.20	22.00	22.90	11.80	.	37.00	29.50
79.80	12.6L	14.60	11.10	65.30	10.00	18.50	15.40L	16.30	10.10	17.30	36.00	18.60
80.81	14.9L	17.10	12.90	55.50	5.00	23.20	22.80	22.30	6.00	11.60	27.00	26.30
81.82	14.4L	18.60	6.96	72.50	5.00L	22.80	20.60L	19.30	2.96	10.50	10.00	20.90
82.83	14.1L	16.90	13.90	72.40	2.00L	20.30	12.60L	13.10	1.93	9.49	24.00	17.50
83.84	9.72	15.20	6.54	55.50	6.00	22.60	14.80L	14.90	5.46	12.50	20.50	14.60
84.85	13.7L	18.50	7.58	57.50	5.00	28.50	10.01L	9.66	2.17	8.00	17.00	13.00
85.86	22.8L	15.69	15.23	75.00	.	24.35	5.42	5.18	5.38	2.00	.	10.19
86.87	4.64	20.35	6.14	.	6.00	17.95	5.92	9.64	7.57	.	30.00	18.46
87.88	5.03	11.72	5.75	65.00	12.00	27.63	9.66	14.03	6.37	24.00	39.00	28.39

Table A6. TON, TN, Secchi and DOC concentrations in Blue Chalk Lake during 1976/77 - 1987/88.

YEAR	TONss	TONif	TONEPI	TONso	TONfo	TONan	TNss	TNif	TNepi	TNso	TNfo	TNan
76.77	162.40	164.20	147.42	.	212.40	160.40	193.81	198.20	161.90	240.00	235.00	194.80
77.78	147.40	148.10	141.20	226.00	83.00	149.30	183.90	185.90	162.15	305.00	115.00	189.30
78.79	219.00	213.10	214.20	.	218.00	233.50	256.50	251.00	235.75	.	260.00	285.20
79.80	218.60	217.70	210.90	212.70	210.00	201.40	246.60	248.60	232.10	295.30	256.00	238.50
80.81	172.20	172.70	167.00	203.40	163.00	166.70	209.90	212.10	185.90	270.50	195.00	216.20
81.82	155.40	157.70	153.04	162.50	200.00	149.10	190.40	195.60	162.96	245.50	215.00	192.80
82.83	150.40	148.90	145.07	124.51	151.00	150.50	177.10	179.90	160.90	206.40	177.00	188.30
83.84	147.20	147.10	146.54	157.50	129.50	143.40	171.72	177.20	158.54	225.50	156.00	180.60
84.85	182.99	175.34	177.83	125.00	173.00	170.00	206.70	203.50	187.58	190.50	195.00	211.50
85.86	116.97	117.82	140.00	128.00	.	125.47	133.92	139.38	160.62	205.00	.	161.34
86.87	128.47	133.43	149.57	.	160.00	134.85	139.03	163.42	163.29	.	196.00	171.26
87.88	122.38	121.61	133.62	106.00	131.00	132.15	137.07	147.36	145.75	195.00	182.00	188.16

YEAR	SDss	SDif	SDso	SDfo	DOCss	DOCif	DOCepi	DOCso	DOCfo	DOCan
76.77	7.32	7.32	6.60	.	.	.	.	.	.	.
77.78	7.21	7.24	8.20	7.20	.	.	.	.	.	.
78.79	5.69	5.77	6.80	6.40	1.84	1.86	1.89	.	2.00	1.84
79.80	6.45	6.53	9.20	5.80	1.90	1.90	1.95	.	1.90	1.88
80.81	6.85	6.92	10.00	5.40	1.97	1.95	2.00	1.70	1.80	1.91
81.82	6.43	6.29	5.35	4.80	1.90	1.86	1.95	1.60	2.00	1.88
82.83	6.49	6.50	8.20	4.90	1.74	1.74	1.81	2.27	1.30	1.66
83.84	6.80	6.51	5.65	4.50	1.77	1.71	1.85	1.30	1.80	1.81
84.85	6.54	6.42	6.15	5.50	1.85	1.82	1.96	1.60	1.70	1.76
85.86	6.81	6.75	6.00	.	1.48	1.48	1.78	1.50	.	1.55
86.87	7.54	7.11	6.65	5.00	1.57	1.60	1.91	1.66	1.80	1.69
87.88	7.64	7.67	10.30	5.30	1.57	1.61	1.79	1.60	1.90	1.47

Table A7. Chlorophyll, TP, NO_3 and NH_4 concentrations in Buck Lake during 1976/77 - 1987/88.

YEAR	CHLss	CHLif	CHLso	CHLfo	CHLan	TPss	TPif	TPepi	TPso	TPfo	TPan
76.77	2.05	1.94	1.75	1.40	1.75	6.91	6.51	5.84	6.00	4.70	6.37
77.78	1.48	1.43	1.25	2.30	1.55	7.73	7.53	7.46	6.95	.	7.43
78.79	1.80	1.97	3.30	1.90	2.28	7.56	7.69	6.09	8.60	.	6.64
79.80	2.98	3.74	5.60	3.80	2.91	6.79	7.10	5.92	6.10	9.65	7.10
80.81	2.92	2.97	3.30	.	2.66	8.02	8.02	5.68	9.94	.	7.95
81.82	3.06	2.88	.	2.00	2.52	6.75	6.72	5.17	.	6.60	6.86
82.83	2.44	2.20	1.00	.	2.30	7.23	7.27	5.88	7.55	.	7.23
83.84	2.64	2.47	1.60	.	2.60	6.91	6.91	5.31	.	.	6.91
84.85	2.35	2.35	.	.	2.13	6.37	6.37	5.03	.	.	6.37
85.86	2.41	2.41	.	.	2.63	6.96	6.96	5.53	.	.	7.19
86.87	2.76	2.76	.	.	2.68	6.66	6.66	5.57	.	.	7.01
87.88	2.52	2.45	2.10	.	2.74	6.93	7.05	5.17	7.75	.	6.92

YEAR	NO_3ss	NO_3if	NO_3epi	NO_3so	NO_3fo	NO_3an	NH_4ss	NH_4if	NH_4epi	NH_4so	NH_4fo	NH_4an
76.77	70.56	89.10	18.50	165.00	45.00	66.10	17.38	14.30	11.70	16.00	14.30	18.40
77.78	53.80	69.20	20.80	112.50	.	69.20	21.67	20.60	13.00	17.50	.	24.40
78.79	62.89	69.80	20.60	120.00	.	67.10	48.92	44.20	26.40	7.00	.	43.10
79.80	47.33	58.70	7.00	87.50	50.00	62.60	10.59	16.00	6.42	14.00	47.00	25.10
80.81	37.37	52.10	16.70	90.92	.	61.60	35.24	28.20	8.00	7.25	.	34.90
81.82	107.56	101.00	40.00	.	65.00	111.00	7.39	6.66	4.40	.	3.00	6.73
82.83	99.68	114.00	21.70	195.00	.	110.00	10.51	10.40	1.67	9.00	.	9.21
83.84	100.31	113.00	44.80	173.00	.	100.00	10.06	8.55	6.80	.	.	10.10
84.85	110.64	107.00	47.50	.	.	107.00	6.60	6.15	3.33	.	.	6.15
85.86	129.16	129.16	79.50	.	.	126.21	8.22	8.22	6.50	.	.	8.38
86.87	132.59	132.59	54.80	.	.	130.97	10.05	10.05	5.60	.	.	12.64
87.88	98.86	107.88	33.17	162.00	.	103.53	15.40	14.91	7.00	12.00	.	15.16

Table A8. TON, TN, Secchi and DOC concentrations in Buck Lake during 1976/77 - 1987/88.

YEAR	TONss	TONif	TONEPI	TONso	TONfo	TONan	TNss	TNif	TNepi	TNso	TNfo	TNan
76.77	212.43	193.70	206.30	189.00	205.70	191.60	300.37	297.10	236.50	370.00	265.00	276.10
77.78	149.69	162.40	152.00	200.00	.	191.60	225.16	252.20	185.80	330.00	.	285.20
78.79	255.22	253.80	251.60	243.00	.	283.90	367.03	367.80	298.60	370.00	.	394.10
79.80	238.30	251.00	251.58	316.00	182.00	257.90	296.22	325.70	265.00	417.50	279.00	345.60
80.81	220.78	234.80	223.00	298.42	.	220.10	293.39	315.10	247.70	396.59	.	316.60
81.82	217.55	219.34	218.60	.	227.00	216.27	332.50	327.00	263.00	.	295.00	334.00
82.83	194.21	194.60	200.33	201.00	.	195.79	304.40	319.00	223.70	405.00	.	315.00
83.84	183.60	187.45	195.20	.	.	183.90	293.97	309.00	246.80	383.00	.	294.00
84.85	207.48	210.85	216.67	.	.	210.85	324.72	324.00	267.50	.	.	324.00
85.86	211.41	211.41	210.17	.	.	210.99	348.78	348.78	296.17	.	.	345.58
86.87	195.43	195.43	208.40	.	.	200.32	338.07	338.07	268.80	.	.	338.86
87.88	187.58	190.98	191.33	208.00	.	188.08	290.90	306.09	231.50	382.00	.	306.77

YEAR	SDss	SDif	SDso	SDfo	DOCss	DOCif	DOCepi	DOCso	DOCfo	DOCan
76.77	7.21	6.70	5.30	4.00	.	.	.	.	.	.
77.78	7.37	6.98	5.80	4.80	.	.	.	.	.	.
78.79	5.71	5.41	3.00	6.40	3.08	3.08	3.26	.	.	3.28
79.80	5.64	5.18	4.70	3.80	3.03	3.12	3.22	3.45	2.90	2.96
80.81	5.93	5.87	5.50	.	3.15	3.11	3.37	2.89	.	3.07
81.82	5.76	5.58	.	4.70	2.83	2.91	3.02	.	3.30	2.77
82.83	5.18	5.51	7.50	.	2.89	2.89	3.05	2.90	.	2.82
83.84	5.96	5.80	5.00	.	2.77	2.70	3.00	2.40	.	2.77
84.85	5.90	5.90	.	.	2.85	2.85	3.08	.	.	2.85
85.86	5.25	5.25	.	.	2.67	2.67	2.82	.	.	2.69
86.87	5.76	5.76	.	.	2.68	2.68	2.92	.	.	2.64
87.88	5.63	5.61	5.50	.	2.69	2.66	2.82	2.50	.	2.66

Table A9. Chlorophyll, TP, NO_3 and NH_4 concentrations in Chub Lake during 1976/77 - 1987/88.

YEAR	CHLss	CHLif	CHLso	CHLfo	CHLan	TPss	TPif	TPepi	TPso	TPfo	TPan
76.77	3.45	3.45	1.77	3.80	2.99	11.60	11.70	9.08	13.30	.	11.90
77.78	1.98	1.99	2.00	2.30	1.63	12.20	12.30	8.89	13.50	.	12.40
78.79	4.41	4.65	1.10	13.40	4.05	12.50	12.50	10.60	11.70	15.10	12.40
79.80	2.34	2.26	1.35	1.90	3.56	11.60	11.50	8.66	10.80	9.40	11.80
80.81	5.78	5.59	5.60	1.60	3.35	12.50	12.50	9.89	12.60	12.50	12.20
81.82	3.96	3.56	1.23	1.70	3.34	10.90	11.20	8.97	12.90	12.30	10.70
82.83	4.23	3.87	1.40	2.05	3.11	11.40	11.30	8.02	9.78	12.30	11.10
83.84	1.87	1.81	1.98	0.80	1.78	9.71	9.79	7.47	10.30	9.70	9.50
84.85	2.92	2.69	1.20	1.30	1.75	9.21	9.29	7.89	9.70	9.87	9.32
85.86	3.49	2.98	0.55	2.70	2.62	8.77	8.85	7.35	8.74	10.03	8.80
86.87	2.68	2.26	1.25	1.00	1.88	8.68	8.77	6.94	8.95	9.10	8.42
87.88	3.94	3.65	0.90	4.10	3.18	9.71	9.79	6.41	9.25	11.05	9.23

YEAR	NO_3ss	NO_3if	NO_3epi	NO_3so	NO_3fo	NO_3an	NH_4ss	NH_4if	NH_4epi	NH_4so	NH_4fo	NH_4an
76.77	32.20L	35.40	8.65	90.00	.	25.90	19.56	19.50	15.70	.	.	29.20
77.78	28.50L	29.00	7.41	33.30	.	52.70	34.40	32.60	17.50	15.70	.	35.60
78.79	113.00L	114.00	39.90	150.00	54.70	105.00	37.60	41.40	18.20	22.50	153.00	41.30
79.80	69.00L	71.80	19.80	113.00	60.00	70.90	25.10	25.80	13.90	17.00	62.00	30.30
80.81	53.30L	56.60	27.50	112.00	35.00	73.60	26.70	25.80	17.80	9.58	33.00	26.20
81.82	82.70L	86.00	20.00	117.00	70.00	89.70	8.64	8.88	5.26	10.30	10.00	8.36
82.83	73.90L	75.70	8.58	128.00	43.00	69.70	10.30	11.20	1.42	3.90L	29.00	14.70
83.84	66.40L	68.50	12.70	89.00	55.00	70.00	8.09	7.95	7.31	2.50	17.00	8.06
84.85	65.10L	68.30	17.70	110.00	65.00	65.20	11.10	11.10	4.08	2.00	20.00	12.70
85.86	80.41	81.75	18.91	105.00	50.00	81.93	11.01	11.58	3.18	9.00	23.00	15.13
86.87	81.55	86.16	23.22	122.00	56.00	89.37	13.45	13.92	4.33	11.00	24.00	16.50
87.88	71.89	74.27	21.78	131.00	39.00	74.10	16.34	18.28	8.00	13.00	41.00	21.78

Table A10. TON, TN, Secchi and DOC concentrations in Chub Lake during 1976/77 - 1987/88.

YEAR	TONss	TONif	TONEPI	TONso	TONfo	TONan	TNss	TNif	TNepi	TNso	TNfo	TNan
76.77	233.50	232.50	231.30	.	.	222.80	285.20	287.40	255.65	340.00	.	277.90
77.78	206.60	206.40	218.50	209.30	.	222.40	269.50	268.00	243.41	258.30	.	310.70
78.79	258.40	252.60	272.80	215.50	214.00	284.70	409.00	408.00	330.90	388.00	421.70	431.00
79.80	317.90	314.20	333.10	278.00	299.00	316.70	412.00	411.80	366.80	408.00	421.00	417.90
80.81	253.30	256.20	263.20	271.42	282.00	257.80	333.30	338.60	308.50	393.00	350.00	357.60
81.82	261.36	261.12	259.74	256.70	260.00	255.64	352.70	356.00	285.00	384.00	340.00	353.70
82.83	247.70	244.80	229.58	220.10	241.00	240.30	331.90	331.70	239.58	352.00	313.00	324.70
83.84	213.91	216.05	209.69	227.50	213.00	214.94	288.40	292.50	229.70	319.00	285.00	293.00
84.85	249.90	245.90	258.92	218.00	220.00	245.30	326.10	325.30	280.70	330.00	305.00	323.20
85.86	216.69	217.33	221.36	206.00	247.00	225.20	308.11	310.66	243.45	320.00	320.00	322.27
86.87	243.90	243.26	241.22	244.00	236.00	220.67	338.90	343.34	268.78	377.00	316.00	326.54
87.88	231.78	230.19	230.89	217.00	229.00	235.84	320.01	322.74	260.67	361.00	309.00	331.71

YEAR	SDss	SDif	SDso	SDfo	DOCss	DOCif	DOCepi	DOCso	DOCfo	DOCan
76.77	4.04	4.04	3.17	.	.	.	.	.	.	.
77.78	4.09	3.90	2.67	2.40	.	.	.	.	.	.
78.79	3.11	3.01	1.80	2.00	4.76	4.76	4.78	.	.	5.02
79.80	2.46	2.45	2.70	1.80	5.14	5.12	5.21	4.90	5.40	5.26
80.81	2.78	2.74	2.90	1.90	5.39	5.38	5.65	5.01	5.60	5.31
81.82	2.99	2.91	2.43	2.50	4.81	4.86	4.86	4.97	5.10	4.86
82.83	3.49	3.44	2.50	2.80	4.73	4.71	4.69	4.19	5.00	4.68
83.84	3.68	3.44	2.50	2.30	4.28	4.25	4.22	4.05	4.30	4.37
84.85	3.10	3.15	3.50	3.50	4.39	4.39	4.56	4.40	4.40	4.37
85.86	3.12	2.98	2.80	2.00	4.20	4.25	4.27	4.20	4.90	4.46
86.87	3.06	2.93	2.70	2.30	4.90	4.83	5.31	4.45	5.00	4.96
87.88	3.90	3.85	4.10	3.10	4.66	4.73	4.66	5.40	4.70	4.47

Table A11. Chlorophyll, TP, NO_3 and NH_4 concentrations in Crosson Lake during 1976/77 - 1987/88.

YEAR	CHLss	CHLif	CHLso	CHLfo	CHLan	TPss	TPif	TPepi	TPso	TPfo	TPan
76.77	3.37	3.37	1.25	3.40	2.46	11.10	11.80	8.38	14.00	.	11.40
77.78	1.80	1.66	1.45	1.20	1.52	11.50	12.10	9.29	14.70	.	12.00
78.79	2.50	2.55	1.20	2.90	2.00	12.20	12.30	9.41	14.00	.	12.30
79.80	1.91	1.81	1.50	1.40	1.78	11.60	11.80	9.42	14.10	11.00	11.30
80.81	3.20	3.18	2.80	.	2.71	11.20	11.30	9.03	13.50	13.90	11.50
81.82	2.00	1.87	0.85	1.00	1.75	11.20	11.20	10.10	12.00	10.30	10.80
82.83	3.02	3.07	1.60	5.10	2.68	10.90	11.00	8.41	12.70	12.00	11.10
83.84	3.02	2.76	1.40	2.40	2.24	11.60	11.60	9.77	11.70	12.00	11.30
84.85	3.61	3.31	2.10	2.20	2.58	10.80	11.00	8.21	11.90	10.90	10.50
85.86	3.04	2.85	2.20	2.10	2.39	10.91	11.02	9.70	11.05	12.37	10.72
86.87	2.01	1.92	2.05	0.60	1.79	10.74	10.26	9.58	7.33	10.90	9.74
87.88	3.71	3.44	1.10	2.80	2.48	10.03	10.10	8.45	9.60	11.40	9.64

YEAR	NO_3ss	NO_3if	NO_3epi	NO_3so	NO_3fo	NO_3an	NH_4ss	NH_4if	NH_4epi	NH_4so	NH_4fo	NH_4an
76.77	.	46.50	15.60	.	.	39.10	.	22.90	9.88	.	.	26.50
77.78	.	66.70	23.30	.	.	99.00	.	26.00	9.33	.	.	27.60
78.79	.	153.00	86.70	.	.	150.00	.	28.20	13.00	.	.	36.30
79.80	123.00L	124.00	64.30	175.00	80.00	122.00	16.60	21.50	11.60	29.00	43.00	21.40
80.81	91.40L	94.70	40.50	160.00	62.00	94.50	12.80	14.30	8.55	13.00	30.90	18.30
81.82	113.00L	114.00	45.20	133.00	110.00	124.00	13.90L	14.00	6.50	19.00	6.00	12.50
82.83	115.00L	103.00	40.70	.	30.90	87.30	8.37L	8.31	3.21	.	7.92	11.20
83.84	44.00L	51.00	14.80	102.00	34.00	60.30	16.70L	15.00	6.46	2.00	20.00	13.30
84.85	57.10L	58.50	7.75	110.00	25.00	77.20	9.47L	9.28	2.58	2.00	14.00	10.80
85.86	81.62	86.29	16.67	120.00	75.00	98.12	10.36	9.69	4.83	3.00	15.00	13.48
86.87	103.15	108.85	32.42	155.00	85.00	113.40	13.05	12.97	6.08	10.00	18.00	14.53
87.88	87.56	90.95	30.08	165.00	61.00	102.36	15.00	16.47	12.31	8.00	44.00	20.28

Table A12. TON, TN, Secchi and DOC concentrations in Crosson Lake during 1976/77 - 1987/88.

YEAR	TONss	TONif	TONEPI	TONso	TONfo	TONan	TNss	TNif	TNepi	TNso	TNfo	TNan
76.77	.	241.10	230.12	.	.	234.50	.	310.50	255.60	.	.	300.10
77.78	.	204.00	191.67	.	.	224.40	.	296.70	224.30	.	.	351.00
78.79	.	263.80	258.00	.	.	275.70	.	445.00	357.70	.	.	462.00
79.80	301.40	292.50	270.40	231.00	297.00	307.60	441.00	438.00	346.30	435.00	420.00	451.00
80.81	261.20	258.70	268.45	227.00	254.10	261.70	365.40	367.70	317.50	400.00	347.00	374.50
81.82	243.10	244.00	241.50	254.00	239.00	240.50	370.00	372.00	293.20	406.00	355.00	377.00
82.83	224.63	224.69	219.79	.	227.08	219.80	348.00	336.00	263.70	.	265.90	318.30
83.84	211.30	212.00	216.54	221.00	195.00	211.70	272.00	278.00	237.80	325.00	249.00	285.30
84.85	254.53	252.72	260.42	223.00	256.00	243.20	321.10	320.50	270.75	335.00	295.00	331.20
85.86	221.88	219.44	226.83	232.00	165.00	221.65	313.86	315.42	248.33	355.00	255.00	333.24
86.87	241.96	240.37	245.58	240.00	222.00	231.47	358.16	362.19	284.08	405.00	325.00	359.00
87.88	223.94	223.24	219.23	222.00	216.00	232.09	326.38	330.90	261.62	395.00	321.00	355.71

YEAR	SDss	SDif	SDso	SDfo	DOCss	DOCif	DOCepi	DOCso	DOCfo	DOCan
76.77	3.83	3.74	3.80	3.00	.	.	.	.	.	.
77.78	4.53	4.10	2.75	4.20	.	.	.	.	.	.
78.79	3.39	3.37	3.00	3.60	4.03	4.03	.	.	.	4.17
79.80	3.10	2.93	2.50	2.20	4.06	4.15	4.00	4.50	4.40	4.51
80.81	3.42	3.43	3.70	.	4.57	4.59	4.65	4.80	.	4.54
81.82	3.24	3.18	2.35	3.40	4.18	4.20	4.17	4.50	3.90	4.16
82.83	3.51	3.57	3.10	4.80	3.89	3.91	3.87	.	3.76	3.98
83.84	3.90	3.68	2.90	2.50	3.87	3.84	3.75	3.80	3.60	3.92
84.85	3.58	3.36	2.45	2.50	3.86	3.87	3.92	4.00	3.80	3.88
85.86	3.16	3.01	2.40	2.50	3.74	3.76	3.74	3.85	.	4.03
86.87	3.16	3.17	3.25	3.10	3.98	4.07	4.13	4.60	4.20	4.05
87.88	3.95	3.89	3.50	3.40	4.02	4.05	4.08	4.40	4.10	3.97

Table A13. Chlorophyll, TP, NO_3 and NH_4 concentrations in Dickie Lake during 1976/77 - 1987/88.

YEAR	CHLss	CHLif	CHLso	CHLfo	CHLan	TPss	TPif	TPepi	TPso	TPfo	TPan
76.77	4.95	4.34	2.00	2.05	5.68	12.00	12.70	13.50	13.50	13.20	13.10
77.78	5.03	5.85	8.25	7.25	4.78	14.40	13.40	11.40	13.70	11.90	11.80
78.79	5.10	5.66	2.80	9.18	5.61	13.10	13.20	12.10	12.40	14.10	13.40
79.80	5.60	5.02	2.90	3.10	4.99	14.80	14.60	13.70	16.90	10.70	13.10
80.81	4.89	4.57	1.60	2.90	4.42	13.00	13.00	12.00	11.50	13.70	12.90
81.82	3.99	3.67	1.05	3.37	3.92	10.60	10.70	10.10	11.50	10.50	9.42
82.83	3.43	3.09	1.40	2.25	6.06	10.60	10.90	10.10	10.20	12.20	12.10
83.84	5.96	6.67	11.70	2.70	3.28	12.70	13.50	10.10	15.60	11.50	11.50
84.85	4.36	3.92	1.70	3.50	5.76	9.13	10.80	8.90	12.60	8.97	10.50
85.86	6.81	6.45	5.05	5.70	3.22	11.96	11.86	10.51	12.35	9.77	10.08
86.87	4.04	3.31	1.25	2.30	3.22	11.58	11.06	10.20	.	12.30	10.75
87.88	3.80	3.41	2.10	2.40	2.25	6.26	6.55	5.76	8.30	.	6.26

YEAR	NO_3ss	NO_3if	NO_3epi	NO_3so	NO_3fo	NO_3an	NH_4ss	NH_4if	NH_4epi	NH_4so	NH_4fo	NH_4an
76.77	65.00	56.30	9.46	87.50	7.50	52.60	15.50	26.70	15.50	.	49.30	30.80
77.78	14.30L	24.30	7.25	110.00	8.00	33.00	25.00	25.40	18.80	9.05	32.80	35.10
78.79	53.70L	51.20	40.30	123.00	5.00	42.20	23.50	38.10	17.50	34.50	83.80	54.60
79.80	9.55L	17.70	5.48	71.70	18.30	36.50	22.10	24.00	17.80	25.70	34.70	26.60
80.81	49.90L	49.90	36.90	120.00	15.00	60.50	20.90	25.90	6.25	30.00	39.00	39.40
81.82	69.20L	65.40	33.00	110.00	21.70	69.80	17.70	25.20	5.65	53.00	34.00	27.10
82.83	46.20L	46.90	19.30	135.00	6.00	39.40	15.80	20.50	1.82	20.00	41.50	17.70
83.84	2.04L	22.40	2.82	40.30	26.00	73.60	12.50	18.30	5.18	2.00	51.50	43.30
84.85	45.50	74.60	12.60	125.00	3.00	50.90	16.10	24.50	3.64	37.00	8.00	7.67
85.86	4.05	18.25	3.64	100.00	11.00	43.37	17.82	17.15	3.36	3.50	37.00	28.55
86.87	26.52	46.56	12.50	127.00	27.00	42.59	18.84	20.38	6.00	28.50	15.00	21.61
87.88	110.51	120.86	47.00	183.00	.	125.45	10.79	10.11	7.50	6.00	.	11.65

Table A14. TON, TN, Secchi and DOC concentrations in Dickie Lake during 1976/77 - 1987/88.

YEAR	TONss	TONif	TONEPI	TONso	TONfo	TONan	TNss	TNif	TNepi	TNso	TNfo	TNan
76.77	246.50	267.30	244.50	.	293.70	236.20	327.00	350.30	269.46	427.50	350.50	319.60
77.78	270.00	245.60	283.20	231.95	215.20	260.90	309.30	295.30	309.25	351.00	256.00	329.00
78.79	304.50	295.90	300.50	270.50	289.20	310.40	381.70	385.20	358.30	428.00	378.00	407.20
79.80	357.90	359.00	352.20	407.30	314.30	345.40	389.50	400.70	375.48	504.10	367.30	408.50
80.81	295.10	294.10	317.75	260.00	331.00	289.60	365.90	369.90	360.90	410.00	385.00	389.50
81.82	286.30	292.80	283.35	265.00	334.00	280.90	373.20	383.40	322.00	428.00	389.70	377.80
82.83	251.20	255.50	241.18	320.00	246.50	270.30	313.20	322.90	262.30	475.00	294.00	327.40
83.84	257.5	264.70	237.82	296.00	228.50	246.70	272.04	305.40	245.82	338.30	306.00	363.60
84.85	276.90	257.50	271.36	246.00	262.00	256.33	338.50	356.60	287.60	408.00	273.00	314.90
85.86	266.04	261.60	246.64	251.50	233.00	254.35	287.91	297.00	253.64	355.00	281.00	326.28
86.87	263.84	266.49	272.33	271.50	275.00	263.25	309.19	333.43	290.83	427.00	317.00	327.45
87.88	241.04	238.61	240.83	224.00	.	243.07	362.34	369.58	295.33	413.00	.	380.18

YEAR	SDss	SDif	SDso	SDfo	DOCss	DOCif	DOCepi	DOCso	DOCfo	DOCan
76.77	2.99	2.95	2.85	2.75	.	.	.	.	.	.
77.78	3.16	2.93	2.50	2.47	.	.	.	.	.	.
78.79	3.03	2.96	2.20	2.85	4.94	4.97	4.77	.	5.20	5.26
79.80	2.25	2.27	2.33	2.40	5.35	5.46	5.25	5.70	5.63	5.58
80.81	2.57	2.49	2.40	1.75	5.58	5.66	5.39	5.60	6.10	5.53
81.82	2.57	2.48	1.70	2.43	5.24	5.39	5.15	5.30	5.67	5.35
82.83	2.99	3.01	3.00	3.10	4.78	4.80	4.75	5.10	4.75	4.84
83.84	2.94	2.67	1.93	2.30	4.70	4.59	4.55	4.53	4.50	4.78
84.85	3.12	2.96	2.10	3.00	5.13	4.78	4.68	4.85	4.30	4.76
85.86	2.86	2.79	2.10	.	4.54	4.58	4.49	4.55	5.00	4.85
86.87	2.54	2.55	2.75	2.20	4.95	5.03	4.87	5.05	5.60	5.30
87.88	3.06	3.19	3.00	4.30	4.02	3.96	4.12	3.60	.	3.98

Table A15. Chlorophyll, TP, NO_3 and NH_4 concentrations in Glen Lake during 1976/77 - 1987/88.

YEAR	CHLss	CHLif	CHLso	CHLfo	CHLan	TPss	TPif	TPepi	TPso	TPfo	TPan
76.77	1.60	1.60	5.17	.	1.40	22.10	22.60	8.42	25.00	.	25.50
77.78	.	3.00	.	3.00	1.53	.	13.70	.	.	13.70	18.00
78.79	2.72	2.90	.	3.35	2.96	19.80	17.20	8.24	.	12.15	21.30
79.80	3.33	3.57	4.80	2.10	4.10	22.90	23.70	7.92	31.30	12.50	18.10
80.81	7.48	6.64	.	1.60	5.56	23.50	24.80	7.76	.	31.50	28.30
81.82	3.66	3.91	6.20	2.90	3.32	21.60	23.10	8.64	37.00	16.50	21.00
82.83	3.92	3.92	.	.	1.46	18.50	18.50	8.93	.	.	18.30
83.84	3.98	3.96	3.90	.	2.24	21.10	22.40	10.50	25.00	.	21.10
84.85	2.23	2.28	2.40	.	3.60	13.10	14.68	6.59	21.00	.	13.10
85.86	3.50	3.50	.	.	.	14.46	13.78	6.33	.	10.40	15.27
86.87	8.36	8.36	.	.	.	17.10	17.10	8.68	.	.	17.24
87.88	3.87	4.70	9.70	.	.	17.21	19.18	7.62	31.00	.	18.61

YEAR	NO_3ss	NO_3if	NO_3epi	NO_3so	NO_3fo	NO_3an	NH_4ss	NH_4if	NH_4epi	NH_4so	NH_4fo	NH_4an
76.77	55.67	75.10	6.67	170.00	.	43.50	35.38	75.50	8.00	.	.	147.00
77.78	.	20.00	.	.	20.00	100.00	.	185.00	.	.	.	178.00
78.79	1.98	5.92	7.50	.	.	45.90	51.75	169.00	15.30	.	320.00	176.00
79.80	18.32	58.30	40.00	125.00	20.00	51.80	161.28	160.00	23.50	155.00	160.00	131.00
80.81	12.31	13.50	5.00	.	.	41.20	154.29	208.00	7.67	.	370.00	234.00
81.82	5.63	54.30	6.00	185.00	10.00	65.40	127.54	122.00	12.00	130.00	85.00	113.00
82.83	42.25	91.60	58.80	.	.	63.50	77.31	77.60	4.60	.	.	82.40
83.84	24.33	71.00	28.00	125.00	.	54.30	110.16	105.00	39.30	100.00	.	95.20
84.85	11.34	24.07	17.75	75.00	.	11.34	68.87	69.29	13.50	71.00	.	68.87
85.86	18.81	17.84	34.40	.	13.00	29.73	46.51	50.92	5.80	.	73.00	58.60
86.87	31.91	31.91	33.40	.	.	34.49	66.23	66.23	12.60	.	.	87.49
87.88	32.66	40.85	64.00	90.00	.	49.07	98.74	102.63	34.17	126.00	.	82.22

Table A16. TON, TN, Secchi and DOC concentrations in Glen Lake during 1976/77 - 1987/88.

YEAR	TONss	TONif	TONEPI	TONso	TONfo	TONan	TNss	TNif	TNepi	TNso	TNfo	TNan
76.77	376.04	381.50	298.00	.	.	369.00	467.09	532.10	312.67	580.00	.	559.50
77.78	.	180.00	.	.	.	212.00	.	385.00	.	.	385.00	490.00
78.79	323.50	263.00	240.70	.	225.00	288.00	377.23	437.92	263.50	.	.	509.90
79.80	322.09	331.00	294.50	360.00	269.00	355.00	501.69	549.30	358.00	640.00	449.00	537.80
80.81	364.47	373.00	264.33	.	280.00	331.00	531.07	594.50	277.00	.	.	606.20
81.82	356.56	369.00	289.00	450.00	350.00	351.00	489.73	545.30	307.00	765.00	445.00	529.40
82.83	340.06	340.40	278.40	.	.	315.60	459.62	509.60	341.80	.	.	461.50
83.84	271.89	251.00	239.70	230.00	.	284.80	406.38	427.00	307.00	455.00	.	434.30
84.85	324.84	325.67	304.00	329.00	.	324.84	405.05	419.04	335.25	475.00	.	405.05
85.86	287.03	282.02	262.20	.	257.00	290.89	352.35	350.79	302.40	.	343.00	379.22
86.87	332.83	332.83	293.40	.	.	324.19	430.97	430.97	339.40	.	.	446.17
87.88	290.31	303.69	264.17	384.00	.	309.06	421.71	447.18	362.33	600.00	.	440.35

YEAR	SDss	SDif	SDso	SDfo	DOCss	DOCif	DOCepi	DOCso	DOCfo	DOCan
76.77	4.47	4.47	3.53	.						
77.78	.	4.60	4.60	4.60						
78.79	4.74	4.73	.	4.70	4.44	4.44	4.63	.	.	3.99
79.80	5.78	5.19	4.40	3.80	3.85	3.76	3.83	3.55	3.80	3.89
80.81	5.97	5.86	.	5.20	4.02	3.98	3.97	.	3.80	3.78
81.82	5.00	5.17	4.00	7.20	4.10	3.95	4.42	3.20	3.90	4.02
82.83	4.48	4.48	.	.	3.57	3.57	3.68	.	.	3.51
83.84	3.90	3.68	2.90	2.50	3.24	3.19	3.47	3.10	.	3.29
84.85	3.43	3.19	2.45	.	3.62	3.58	3.63	3.40	.	3.62
85.86	5.24	5.11	.	4.20	5.11	4.84	4.82	.	3.50	4.63
86.87	4.58	4.58	.	.	3.56	3.56	3.68	.	.	3.40
87.88	6.18	5.99	4.80	.	3.45	3.37	3.45	2.90	.	3.46

Table A17. Chlorophyll, TP, NO_3 and NH_4 concentrations in Gullfeather Lake during 1976/77 - 1987/88.

YEAR	CHLss	CHLif	CHLso	CHLfo	CHLan	TPss	TPif	TPepi	TPso	TPfo	TPan
76.77	4.87	4.67	3.15	5.90	4.32	13.80	12.70	12.50	9.00	14.40	14.30
77.78	4.48	4.99	.	6.25	4.18	18.40	16.00	14.90	.	13.63	13.60
78.79	5.92	4.93	.	2.45	3.79	13.70	14.20	12.60	13.80	15.17	13.60
79.80	3.96	3.66	1.90	3.90	3.54	11.80	11.20	11.60	10.20	9.40	11.00
80.81	5.27	4.81	.	2.10	3.83	13.30	12.90	11.70	.	10.85	12.30
81.82	3.50	3.30	2.10	3.50	3.37	11.80	12.20	10.20	13.00	12.70	12.50
82.83	4.78	4.60	2.20	6.10	5.11	14.00	13.20	11.80	11.00	12.50	13.40
83.84	4.80	5.68	5.10	8.00	5.68	13.10	12.60	9.67	12.20	10.80	12.40
84.85	4.80	4.80	.	.	3.80	12.70	12.60	13.20	12.30	.	12.70
85.86	3.71	3.31	1.40	3.20	3.35	13.41	13.13	10.65	11.70	13.17	12.96
86.87	4.98	4.53	2.30	.	5.02	12.64	12.37	10.95	11.00	.	12.94
87.88	4.08	4.07	4.30	3.80	4.30	14.53	13.91	11.90	12.90	11.85	13.75

YEAR	NO_3ss	NO_3if	NO_3epi	NO_3so	NO_3fo	NO_3an	NH_4ss	NH_4if	NH_4epi	NH_4so	NH_4fo	NH_4an
76.77	21.88	54.50	21.30	102.50	5.00	21.20	18.86	21.70	13.40	.	21.80	37.30
77.78	15.37	22.40	7.50	.	20.00	90.90	64.93	51.20	9.28	.	25.50	50.20
78.79	329.67	278.00	323.00	185.00	87.50	287.00	67.79	76.10	10.60	20.00	91.50	74.10
79.80	85.48	113.00	75.00	320.00	40.00	92.10	43.98	52.10	29.00	36.00	63.00	69.30
80.81	56.12	49.10	48.30	.	25.00	62.40	63.98	60.70	10.70	.	51.00	57.80
81.82	37.76	75.00	35.00	165.00	20.00	66.70	50.14	32.50	19.60	30.00	42.00	33.60
82.83	17.30	44.90	3.00	150.00	3.00	29.90	54.33	38.50	1.20	14.00	12.00	36.40
83.84	10.10	20.30	6.50	75.00	0.00	22.40	22.63	16.70	10.80	8.00	.	14.10
84.85	4.00	22.00	3.00	95.00	.	3.73	36.28	40.70	1.67	8.00	.	48.90
85.86	22.15	39.40	15.40	150.00	15.00	57.76	68.15	58.39	5.80	11.00	57.00	62.33
86.87	51.18	75.99	39.00	200.00	.	63.11	42.24	41.70	9.60	39.00	.	41.92
87.88	36.53	55.66	32.80	167.00	40.00	42.24	60.20	54.14	18.80	29.00	49.00	55.23

Table A18. TON, TN, Secchi and DOC concentrations in Gullfeather Lake during 1976/77 - 1987/88.

YEAR	TONss	TONif	TONEPI	TONso	TONfo	TONan	TNss	TNif	TNepi	TNso	TNfo	TNan
76.77	338.87	297.30	289.60	217.50	285.00	267.70	379.61	373.50	324.30	422.50	295.00	326.20
77.78	163.48	272.80	216.72	.	215.00	301.80	243.78	346.40	233.50	.	355.00	442.90
78.79	351.43	326.90	339.40	160.00	327.50	322.90	748.89	681.00	673.00	530.00	502.50	684.00
79.80	350.12	326.90	319.00	5.00	320.00	327.70	479.58	492.00	423.00	645.00	400.00	489.10
80.81	367.27	359.30	367.30	.	325.00	353.20	487.37	469.10	426.30	.	375.00	473.40
81.82	265.97	287.50	242.40	195.00	275.00	265.40	353.87	395.00	297.00	525.00	315.00	365.70
82.83	263.91	266.50	255.80	110.00	252.00	268.60	335.54	349.90	260.00	410.00	258.00	334.90
83.84	255.93	250.30	224.20	215.00	.	239.90	288.66	287.30	241.50	365.00	200.00	276.40
84.85	297.29	300.30	282.33	135.00	.	319.10	337.57	363.00	287.00	325.00	.	371.73
85.86	226.04	238.89	222.20	259.00	283.00	255.55	316.34	336.67	243.40	420.00	355.00	375.64
86.87	270.87	287.56	292.40	210.00	.	282.87	364.30	405.25	341.00	610.00	.	387.90
87.88	263.37	266.98	287.20	291.00	261.00	263.66	360.09	376.78	338.80	487.00	350.00	361.13

YEAR	SDss	SDif	SDso	SDfo	DOCss	DOCif	DOCepi	DOCso	DOCfo	DOCan
76.77	2.84	2.73	2.60	2.00	.	.	.	.	.	.
77.78	3.22	2.90	.	2.10	.	.	.	.	.	.
78.79	2.38	2.18	1.90	1.95	5.35	5.41	5.20	.	5.60	5.45
79.80	2.46	2.33	2.00	2.00	5.21	5.24	5.10	5.40	5.20	5.69
80.81	2.30	2.26	.	2.00	5.61	5.61	5.64	.	5.60	5.69
81.82	2.20	2.14	1.30	2.70	5.26	5.33	4.94	5.70	5.20	5.06
82.83	2.58	2.56	2.00	3.00	4.70	4.56	4.53	4.70	4.00	4.58
83.84	2.18	2.05	1.60	2.00	4.64	4.58	4.48	4.70	4.20	4.58
84.85	2.82	2.60	1.30	.	4.75	4.76	4.58	4.80	.	4.75
85.86	2.50	2.35	1.60	2.50	5.40	5.29	5.46	5.00	5.00	5.37
86.87	2.44	2.37	2.00	.	5.34	5.34	5.30	.	.	5.35
87.88	2.64	2.67	1.90	3.60	5.23	5.18	5.04	5.40	4.70	5.09

Table A19. Chlorophyll, TP, NO_3 and NH_4 concentrations in Harp Lake during 1976/77 - 1987/88.

YEAR	CHLss	CHLif	CHLso	CHLfo	CHLan	TPss	TPif	TPepi	TPso	TPfo	TPan
76.77	2.96	2.71	0.95	1.80	2.41	7.95	8.09	7.31	8.00	10.50	8.00
77.78	2.92	2.78	1.77	2.90	2.35	8.36	8.21	7.54	6.65	9.20	8.09
78.79	2.55	2.42	1.25	2.00	2.41	7.24	7.53	6.19	8.60	11.60	7.44
79.80	3.21	3.08	1.60	2.10	2.76	7.49	7.48	6.39	8.45	6.80	7.66
80.81	3.55	3.42	1.00	2.90	2.88	8.91	9.02	8.29	11.00	.	8.20
81.82	2.95	2.84	0.80	3.50	2.81	6.98	7.04	6.48	7.00	7.87	7.25
82.83	4.48	3.96	1.25	3.20	3.45	8.11	8.09	6.64	8.25	7.57	7.75
83.84	3.17	2.93	1.50	2.90	2.48	7.77	7.71	6.20	7.30	7.74	7.67
84.85	3.56	3.30	1.40	2.10	2.46	6.66	6.77	5.77	8.60	6.40	6.72
85.86	3.86	3.31	0.50	2.90	2.99	7.28	7.31	6.52	7.38	7.40	6.96
86.87	5.13	4.29	1.35	1.00	3.45	7.64	7.51	6.62	6.10	9.10	7.71
87.88	3.98	3.68	1.00	2.80	3.17	7.06	7.02	6.15	7.45	6.20	6.65

YEAR	NO_3ss	NO_3if	NO_3epi	NO_3so	NO_3fo	NO_3an	NH_4ss	NH_4if	NH_4epi	NH_4so	NH_4fo	NH_4an
76.77	49.90L	57.10	9.50	113.00	60.00	46.70	12.30	12.40	10.80	.	14.20	12.10
77.78	55.50L	55.00	5.74	53.30	45.70	64.00	11.80	11.20	10.80	6.53	6.75	16.10
78.79	89.30L	92.40	14.00	125.00	90.00	97.80	13.10	13.30	10.60	9.50	26.00	18.00
79.80	83.70L	88.90	20.20	133.00	105.00	97.40	8.74L	9.85	8.00	7.00	25.50	9.67
80.81	101.00L	106.00	36.40	160.00	.	118.00	9.28	8.84	8.82	4.00	.	9.25
81.82	121.00L	123.00	40.40	170.00	105.00	126.00	3.86	3.74	2.76	5.00	1.00L	3.54
82.83	94.70L	104.00	12.80	180.00	70.00	98.70	2.18	2.21	2.00	3.00	1.00	2.84
83.84	84.70L	86.70	20.20	125.00	62.00	88.40	3.48	2.89	4.54	1.00L	1.00L	4.06
84.85	86.00L	89.20	4.92	130.00	90.00	107.00	5.62	5.41	2.33	5.00	3.00	4.24
85.86	111.25	117.77	26.42	157.50	110.00	120.29	4.00	4.29	4.92	3.50	9.00	4.79
86.87	112.50	119.53	20.18	164.00	109.00	124.96	5.89	5.42	4.18	3.00	5.00	6.96
87.88	106.03	109.36	19.31	170.00	92.00	115.13	8.92	8.93	8.31	2.00	16.00	7.97

Table A20. TON, TN, Secchi and DOC concentrations in Harp Lake during 1976/77 - 1987/88.

YEAR	TONss	TONif	TONEPI	TONso	TONfo	TONan	TNss	TNif	TNepi	TNso	TNfo	TNan
76.77	201.70	215.60	21[illegible]20	.	295.20	202.90	263.90	285.10	232.50	433.00	370.00	261.70
77.78	181.20	184.80	18[illegible].20	170.47	313.25	206.90	248.50	251.00	201.74	230.30	365.70	287.00
78.79	233.90	237.70	259.40	223.50	334.00	250.00	336.30	343.40	284.00	358.00	450.00	365.80
79.80	264.20	267.15	281.00	291.00	273.50	264.33	356.70	365.90	309.20	431.00	404.00	371.40
80.81	243.72	241.16	267.18	186.00	.	237.75	354.00	356.00	312.40	350.00	.	365.00
81.82	214.14	215.26	223.24	223.00	222.00	211.46	339.00	342.00	266.40	398.00	328.00	341.00
82.83	204.82	203.79	209.00	200.00	209.00	201.16	301.70	310.00	223.80	383.00	280.00	302.70
83.84	190.52	188.11	200.46	184.00	179.00	190.94	278.70	277.70	225.20	310.00	242.00	283.40
84.85	219.38	216.59	255.67	180.00	217.00	213.76	311.00	311.20	262.92	315.00	310.00	325.00
85.86	202.88	205.41	226.75	201.50	241.00	207.40	318.14	327.46	258.08	362.50	360.00	332.49
86.87	210.91	208.31	229.45	187.00	225.00	196.27	327.70	332.54	253.82	389.00	339.00	328.06
87.88	192.37	190.86	205.54	178.00	184.00	197.16	307.33	309.15	233.15	350.00	292.00	320.26

YEAR	SDss	SDif	SDso	SDfo	DOCss	DOCif	DOCepi	DOCso	DOCfo	DOCan
76.77	4.39	4.48	5.40	4.00	.	.	.	.	.	.
77.78	4.33	4.32	4.60	3.30	.	.	.	.	.	.
78.79	3.40	3.37	3.10	3.40	3.98	4.01	4.41	.	4.20	4.19
79.80	3.56	3.54	4.30	2.50	4.11	4.21	4.48	4.90	4.10	4.11
80.81	3.44	3.49	5.00	3.00	4.08	4.02	4.51	3.20	.	4.07
81.82	3.79	3.82	5.00	3.60	3.98	4.03	4.28	4.10	4.30	4.01
82.83	3.75	3.83	4.30	4.00	3.70	3.68	3.91	3.10	4.00	3.67
83.84	3.85	3.80	3.95	3.35	3.57	3.55	3.81	3.25	3.70	3.67
84.85	3.95	4.00	5.20	3.50	3.78	3.77	4.38	3.80	3.70	3.75
85.86	3.29	3.37	4.00	3.00	3.71	3.75	4.35	3.75	4.20	3.86
86.87	3.32	3.54	4.85	3.40	3.88	3.94	4.35	4.00	4.40	3.90
87.88	4.40	4.53	6.00	4.70	3.60	3.66	3.85	4.30	3.80	3.53

Table A21. Chlorophyll, TP, NO_3 and NH_4 concentrations in Little Clear Lake during 1976/77 - 1987/88.

YEAR	CHLss	CHLif	CHLso	CHLfo	CHLan	TPss	TPif	TPepi	TPso	TPfo	TPan
76.77	2.46	2.46	2.35	4.20	1.97	17.00	15.70	8.39	8.50	.	14.60
77.78	2.50	2.21	1.35	0.80	1.89	12.80	12.00	7.83	8.85	.	10.20
78.79	2.59	2.31	1.35	3.50	1.97	10.80	10.20	7.21	8.13	.	9.58
79.80	1.94	1.69	1.25	1.30	2.05	9.98	9.38	6.34	8.28	9.15	8.92
80.81	3.35	3.17	.	2.10	2.49	11.40	10.90	6.40	.	7.90	10.20
81.82	2.48	2.10	1.00	1.30	2.08	8.87	9.42	5.36	9.87	11.70	9.31
82.83	3.06	2.87	1.90	.	3.37	12.50	11.90	6.45	9.07	.	11.90
83.84	3.78	3.80	3.90	.	3.64	10.50	10.20	7.15	9.07	.	10.50
84.85	3.02	3.02	.	.	2.78	9.61	9.61	4.84	.	.	9.61
85.86	2.41	2.41	.	.	2.46	9.29	9.29	4.71	.	.	9.41
86.87	3.54	3.54	.	.	3.38	9.77	9.77	5.69	.	.	9.54
87.88	3.64	3.45	2.50	.	3.58	10.06	9.48	5.17	5.95	.	9.86

YEAR	NO_3ss	NO_3if	NO_3epi	NO_3so	NO_3fo	NO_3an	NH_4ss	NH_4if	NH_4epi	NH_4so	NH_4fo	NH_4an
76.77	22.43	58.90	9.89	192.50	.	64.70	25.60	47.40	12.40	82.00	.	91.50
77.78	14.66	45.60	14.20	135.00	.	69.50	99.10	92.20	23.80	71.50	.	99.70
78.79	36.99	66.60	14.30	167.50	.	68.10	138.94	138.00	44.00	22.50	.	160.00
79.80	29.24	68.60	15.00	180.00	35.00	55.30	100.29	127.00	18.70	46.00	420.00	143.00
80.81	55.57	47.40	51.70	.	20.00	67.40	116.03	122.00	10.00	.	140.00	119.00
81.82	51.54	70.30	27.00	205.00	25.00	64.80	66.64	79.30	7.40	77.00	145.00	76.10
82.83	31.80	62.10	4.20	210.00	.	54.20	74.05	64.70	2.00	17.00	.	64.70
83.84	21.68	44.30	10.00	156.00	.	12.40	72.70	61.10	14.60	3.00	.	71.30
84.85	52.22	40.90	15.50	.	.	40.90	45.05	46.90	4.50	.	.	46.90
85.86	74.56	74.56	35.33	.	.	77.59	64.67	64.67	9.33	.	.	70.34
86.87	63.26	63.26	46.80	.	.	67.94	73.99	73.99	3.60	.	.	75.72
87.88	40.50	58.71	27.33	168.00	.	45.35	95.78	91.81	13.33	68.00	.	93.69

Table A22. TON, TN, Secchi and DOC concentrations in Little Clear Lake during 1976/77 - 1987/88.

YEAR	TONss	TONif	TONEPI	TONso	TONfo	TONan	TNss	TNif	TNepi	TNso	TNfo	TNan
76.77	360.91	398.60	231.60	230.50	.	348.50	408.94	504.90	253.89	505.00	.	504.70
77.78	288.13	270.80	207.20	218.50	.	264.30	401.89	408.60	245.20	425.00	.	433.50
78.79	275.99	216.00	256.00	150.00	.	267.00	451.92	420.60	314.30	340.00	.	495.10
79.80	272.49	243.00	257.30	259.00	68.00	267.00	402.02	438.60	291.00	485.00	523.00	465.30
80.81	293.76	281.00	252.00	.	220.00	234.00	465.36	450.40	313.70	.	380.00	420.40
81.82	214.50	212.70	203.60	178.00	235.00	215.90	332.68	362.30	238.00	460.00	405.00	356.80
82.83	197.91	193.30	182.00	173.00	.	197.30	303.76	320.10	188.20	400.00	.	316.20
83.84	194.33	193.90	182.40	192.00	.	193.70	288.71	299.30	207.00	351.00	.	277.40
84.85	240.52	235.10	223.50	.	.	235.10	337.79	322.90	243.50	.	.	322.90
85.86	204.04	204.04	180.67	.	.	208.14	343.27	343.27	225.33	.	.	356.06
86.87	183.81	183.81	196.40	.	.	173.42	321.05	321.05	246.80	.	.	307.94
87.88	178.17	172.15	171.67	142.00	.	180.53	303.84	316.20	212.33	378.00	.	319.57

YEAR	SDss	SDif	SDso	SDfo	DOCss	DOCif	DOCepi	DOCso	DOCfo	DOCan
76.77	5.84	5.84	5.70	.	.	.	.	.	.	.
77.78	6.27	5.76	4.25	3.00	.	.	.	.	.	.
78.79	5.19	4.92	4.00	7.20	2.89	2.89	2.80	.	.	3.44
79.80	4.74	4.74	5.60	3.00	3.10	3.66	3.02	5.20	2.80	2.97
80.81	5.40	5.13	.	3.50	2.94	2.97	3.02	.	3.10	2.83
81.82	5.30	5.06	5.40	3.50	2.57	2.62	2.64	2.40	3.10	2.62
82.83	4.96	5.12	5.90	.	2.65	2.59	2.52	2.30	.	2.48
83.84	5.28	5.00	3.60	.	2.49	2.37	2.80	1.90	.	2.58
84.85	5.42	5.42	.	.	2.59	2.59	2.85	.	.	2.59
85.86	4.92	4.92	.	.	2.51	2.51	2.57	.	.	2.50
86.87	5.08	5.08	.	.	2.47	2.47	2.52	.	.	2.43
87.88	6.93	6.80	6.00	.	2.52	2.47	2.50	2.20	.	2.50

Table A23. Chlorophyll, TP, NO_3 and NH_4 concentrations in Red Chalk Main during 1976/77 - 1987/88.

YEAR	CHLss	CHLif	CHLso	CHLfo	CHLan	TPss	TPif	TPepi	TPso	TPfo	TPan
76.77	2.32	2.10	1.03	1.30	1.84	5.61	5.54	4.68	4.96	6.40	5.72
77.78	1.81	1.75	1.30	1.50	1.61	6.09	6.13	5.39	6.75	5.08	5.81
78.79	2.12	2.09	1.10	2.40	1.90	5.55	5.59	5.12	4.71	7.35	5.58
79.80	1.99	2.01	1.40	2.25	2.14	5.10	5.07	4.38	10.10	4.70	5.00
80.81	2.82	2.72	2.00	1.30	2.18	5.76	5.84	4.60	.	7.35	5.49
81.82	2.58	2.49	0.75	3.10	2.19	5.41	5.47	5.08	4.67	6.98	5.42
82.83	2.02	1.85	0.50	1.45	1.74	4.99	4.99	4.30	5.34	4.60	4.84
83.84	2.50	2.24	1.03	1.90	1.84	4.82	4.87	4.23	4.48	5.62	4.93
84.85	2.90	2.48	0.75	1.30	1.90	5.03	5.11	3.95	5.49	5.40	4.99
85.86	2.12	1.87	0.35	.	1.58	4.90	4.97	4.22	5.40	.	4.51
86.87	1.70	1.50	1.00	1.30	1.48	4.89	4.61	3.85	3.75	4.65	4.46
87.88	2.51	2.22	0.90	1.50	2.05	4.71	4.62	3.42	3.90	4.55	4.50

YEAR	NO_3ss	NO_3if	NO_3epi	NO_3so	NO_3fo	NO_3an	NH_4ss	NH_4if	NH_4epi	NH_4so	NH_4fo	NH_4an
76.77	52.90L	58.30	15.50	104.00	25.00	53.70	8.73	8.61	6.94	8.01	7.70	11.80
77.78	71.20L	72.90	15.70	83.30	85.70	79.50	11.90	11.50	10.40	8.37	11.30	12.80
78.79	128.00L	129.00	50.40	156.00	110.00	123.00	16.60	18.10	13.60	12.80	58.00	21.50
79.80	88.00L	88.30	28.40	.	92.50	94.80	16.00	18.10	14.90	.	41.50	19.10
80.81	100.00L	102.00	40.40	143.00	85.00	108.00	13.10	13.20	6.50	9.92	18.00	16.10
81.82	109.00L	110.00	24.80	143.00	92.50	113.00	7.74	7.82	4.00	14.00	2.50	6.82
82.83	98.10L	99.50	34.50	149.00	70.00	96.10	3.48	4.02	3.29	5.56	10.00	5.38
83.84	81.70L	85.30	20.50	118.00	74.50	89.10	4.86	5.30	5.23	5.00	8.25	5.72
84.85	70.00L	82.60	12.40	120.00	75.00	75.70	3.21	3.95	2.75	5.00	10.00	4.60
85.86	92.51	97.51	29.46	130.00	.	104.41	5.97	5.37	7.54	1.50	.	6.85
86.87	107.46	114.22	28.86	149.00	93.00	116.75	8.39	8.07	8.71	7.50	7.00	7.96
87.88	102.67	105.73	32.38	151.00	85.00	102.47	6.10	7.38	7.50	4.00	21.00	17.12

Table A24. TON, TN, Secchi and DOC concentrations in Red Chalk Main during 1976/77 - 1987/88.

YEAR	TONss	TONif	TONEPI	TONso	TONfo	TONan	TNss	TNif	TNepi	TNso	TNfo	TNan
76.77	170.27	169.39	193.06	159.99	197.30	175.20	231.90	236.30	215.50	272.00	230.00	240.70
77.78	149.10	155.50	144.60	221.63	94.70	158.20	232.20	239.90	170.70	313.30	191.70	250.50
78.79	232.40	225.90	254.40	71.20	232.00	252.50	377.00	373.00	318.40	240.00	400.00	397.00
79.80	221.00	218.90	193.10	.	210.50	223.90	325.00	325.30	236.40	.	344.50	337.80
80.81	194.90	194.80	195.50	196.08	192.00	177.90	308.00	310.00	242.40	349.00	295.00	302.00
81.82	166.26	166.18	167.00	151.00	185.50	161.18	283.00	284.00	195.80	308.00	280.50	281.00
82.83	154.52	152.98	159.71	142.44	140.00	151.62	256.10	256.50	197.50	297.00	220.00	253.10
83.84	154.14	148.70	155.77	133.00	134.75	152.28	240.70	239.30	181.50	256.00	217.50	247.10
84.85	211.79	199.05	190.25	143.00	170.00	204.40	285.00	285.60	205.40	268.00	255.00	284.70
85.86	139.94	140.41	143.23	143.50	.	146.37	238.42	243.30	180.23	275.00	.	257.63
86.87	155.23	154.46	165.57	167.50	123.00	142.50	271.08	276.75	203.14	324.00	223.00	267.22
87.88	144.75	143.30	148.75	136.00	139.00	153.46	253.52	256.41	188.62	291.00	245.00	273.05

YEAR	SDss	SDif	SDso	SDfo	DOCss	DOCif	DOCepi	DOCso	DOCfo	DOCan
76.77	6.80	6.65	5.87	.	.	.	.	.	.	.
77.78	6.50	6.46	6.10	6.60	.	.	.	.	.	.
78.79	5.50	5.42	4.60	4.20	2.54	2.54	2.81	.	2.60	2.61
79.80	6.13	5.96	4.20	3.75	2.51	2.52	2.72	.	2.60	2.60
80.81	5.65	5.56	5.30	3.90	2.63	2.62	2.85	2.40	2.60	2.58
81.82	5.39	5.35	5.50	4.80	2.42	2.45	2.55	2.40	2.65	2.44
82.83	6.23	6.13	7.00	5.15	2.36	2.38	2.54	2.39	2.60	2.40
83.84	5.94	5.75	6.15	4.10	2.40	2.38	2.60	2.10	2.50	2.48
84.85	6.79	6.56	5.55	5.80	2.54	2.52	2.72	2.40	2.40	2.52
85.86	5.65	5.54	4.85	.	2.27	2.29	2.42	2.40	.	2.33
86.87	6.53	6.38	6.25	5.60	2.39	2.40	2.61	2.40	2.50	2.55
87.88	7.28	7.33	9.10	6.00	2.43	2.47	2.56	2.70	2.50	2.36

Table A25. Chlorophyll, TP, NO_3 and NH_4 concentrations in Red Chalk East during 1976/77 - 1987/88.

YEAR	CHLss	CHLif	CHLso	CHLfo	CHLan	TPss	TPif	TPepi	TPso	TPfo	TPan
76.77	.	.	.	.	1.64	.	.	.	.	.	6.94
77.78	2.26	2.24	2.27	1.70	2.01	8.74	8.56	5.54	7.52	7.35	8.47
78.79	2.82	2.83	1.30	3.00	2.48	7.47	7.38	4.95	6.69	5.45	7.15
79.80	2.42	2.39	1.90	2.20	2.49	7.36	7.33	4.66	8.09	5.95	7.05
83.84	2.82	2.69	1.25	4.00	2.21	7.36	7.10	5.02	6.69	5.17	7.09
84.85	3.14	2.83	1.15	2.44	2.25	7.11	7.23	4.37	7.92	6.20	6.98
85.86	3.01	2.66	0.55	.	2.26	7.22	7.16	4.44	6.79	6.13	6.74
86.87	3.02	2.46	1.25	1.50	2.00	8.24	7.31	4.89	.	5.55	7.01
87.88	2.76	2.47	0.90	2.00	1.82	9.12	8.48	4.28	7.05	4.80	7.14

YEAR	NO_3ss	NO_3if	NO_3epi	NO_3so	NO_3fo	NO_3an	NH_4ss	NH_4if	NH_4epi	NH_4so	NH_4fo	NH_4an
76.77	.	.	.	.	.	53.10	.	.	.	.	.	40.70
77.78	15.30	21.60	15.40	63.30	60.00	37.00	59.00	54.90	20.80	18.50	83.00	72.00
78.79	68.90	66.90	46.70	211.00	25.00	55.90	65.70	67.80	21.20	18.50	92.00	83.60
79.80	20.30	22.10	16.90	60.90	25.00	26.20	78.60	89.30	13.30	57.40	.	96.40
83.84	16.80	22.20	11.90	62.00	12.00	32.20	51.30	52.40	8.54	62.00	47.50	56.10
84.85	15.80	24.60	8.58	77.50	30.00	14.60	56.20	54.90	3.92	47.00	70.00	60.00
85.86	28.17	40.08	18.75	117.50	8.00	53.56	55.95	51.29	6.00	21.00	80.00	54.25
86.87	28.08	51.83	11.29	.	15.00	34.36	63.76	56.84	6.86	.	70.00	80.51
87.88	21.91	28.52	22.25	83.00	27.00	45.27	74.58	77.16	14.13	92.00	83.00	85.18

Table A26. TON, TN, Secchi and DOC concentrations in Red Chalk East during 1976/77 - 1987/88.

YEAR	TONss	TONif	TONEPI	TONso	TONfo	TONan	TNss	TNif	TNepi	TNso	TNfo	TNan
76.77	.	.	.	.	.	191.30	.	.	.	.	.	285.10
77.78	195.00	193.10	179.20	166.50	192.00	194.00	269.30	269.60	215.40	248.30	335.00	303.00
78.79	265.30	270.20	270.80	.	383.00	282.40	399.90	404.90	338.70	.	500.00	421.90
79.80	246.40	239.70	244.70	313.60	.	244.60	345.30	351.10	274.90	431.90	401.00	367.20
83.84	173.70	169.60	166.46	153.00	157.50	173.90	241.80	244.20	186.90	277.00	217.00	262.20
84.85	222.80	214.10	211.08	161.00	180.00	220.00	294.80	293.60	223.58	285.50	280.00	294.60
85.86	174.59	173.84	164.00	169.00	160.00	175.96	258.71	265.22	188.75	307.50	248.00	283.78
86.87	202.97	196.54	188.86	.	190.00	183.11	294.81	305.21	207.00	.	275.00	297.99
87.88	188.86	184.59	155.87	188.00	147.00	179.56	285.35	290.28	192.25	363.00	257.00	310.00

YEAR	SDss	SDif	SDso	SDfo	DOCss	DOCif	DOCepi	DOCso	DOCfo	DOCan
76.77	.	.	.	.	.	.	.	.	.	.
77.78	5.28	5.22	5.00	3.90	.	.	.	.	.	.
78.79	4.85	4.80	4.40	3.60	2.96	3.01	2.95	.	3.40	2.98
79.80	4.74	4.68	5.00	2.80	3.06	3.03	3.02	2.35	3.40	3.18
83.84	4.82	4.61	4.05	3.00	2.74	2.69	2.81	2.20	3.00	2.82
84.85	5.16	5.04	4.35	4.82	2.75	2.72	2.80	2.55	2.70	2.74
85.86	4.53	4.44	3.95	.	2.55	2.55	2.52	2.55	3.10	2.74
86.87	4.74	4.67	5.25	3.00	2.89	2.84	2.94	.	3.10	2.94
87.88	6.04	5.34	6.00	5.20	2.68	2.69	2.61	2.70	2.80	2.54

Table A27. Chlorophyll, TP, NO_3 and NH_4 concentrations in Solitaire Lake during 1976/77 - 1987/88.

YEAR	CHLss	CHLif	CHLso	CHLfo	CHLan	TPss	TPif	TPepi	TPso	TPfo	TPan
76.77	2.18	2.18	2.23	.	1.86	7.39	7.11	5.22	6.25	.	6.69
77.78	1.91	1.77	1.25	2.50	1.55	6.95	6.44	6.64	5.18	.	7.03
78.79	1.48	1.40	0.90	1.80	1.41	5.86	5.90	5.93	6.20	.	5.52
79.80	1.78	1.51	0.95	1.30	1.49	5.53	4.43	5.20	3.45	.	4.52
80.81	1.68	1.79	2.40	.	1.51	6.73	6.56	5.00	5.67	.	6.10
81.82	1.75	1.60	0.70	1.75	1.53	6.28	6.31	4.95	4.85	.	6.61
82.83	2.56	2.25	0.70	.	2.47	6.78	6.82	4.55	7.03	.	6.64
83.84	1.96	1.97	2.00	.	1.95	5.86	5.84	5.06	5.77	.	6.00
84.85	1.38	1.47	1.90	.	1.37	6.01	6.12	4.81	6.70	.	6.01
85.86	1.83	1.83	.	.	1.85	5.94	5.94	4.62	.	.	5.72
86.87	2.05	2.05	.	.	2.12	5.81	5.81	4.26	.	.	5.90
87.88	1.78	1.73	1.50	.	1.74	5.34	5.33	3.58	5.25	.	5.42

YEAR	NO_3ss	NO_3if	NO_3epi	NO_3so	NO_3fo	NO_3an	NH_4ss	NH_4if	NH_4epi	NH_4so	NH_4fo	NH_4an
76.77	56.94	72.20	11.30	140.00	.	57.70	15.69	14.60	6.78	8.00	.	16.00
77.78	53.84	65.50	14.30	105.00	.	67.60	18.75	16.20	11.70	7.50	.	20.70
78.79	54.19	63.20	22.90	103.00	.	64.70	26.25	17.10	15.30	9.00	.	25.50
79.80	52.31	67.20	9.06	102.50	65.00	78.10	7.28	12.70	4.32	17.50	30.00	13.70
80.81	49.84	70.10	15.00	126.00	.	81.70	12.26	11.20	8.00	8.21	.	14.00
81.82	76.51	81.60	40.00	140.00	65.00	78.10	18.66	12.70	6.20	5.00	1.50	16.60
82.83	58.44	72.60	8.83	155.00	.	64.60	6.41	9.24	1.50	26.00	.	6.24
83.84	45.57	54.70	3.40	99.00	.	51.50	12.42	11.20	6.00	5.00	.	11.00
84.85	37.78	45.00	7.20	80.00	.	38.00	7.36	6.80	2.20	4.00	.	7.36
85.86	93.48	93.48	32.67	.	.	96.67	9.06	9.06	3.33	.	.	8.23
86.87	92.61	92.61	44.40	.	.	86.40	7.96	7.96	2.80	.	.	10.58
87.88	73.22	79.34	25.83	116.00	.	77.43	13.41	13.35	4.67	13.00	.	14.08

Table A28. TON, TN, Secchi and DOC concentrations in Solitaire Lake during 1976/77 - 1987/88.

YEAR	TONss	TONif	TONEPI	TONso	TONfo	TONan	TNss	TNif	TNepi	TNso	TNfo	TNan
76.77	190.72	192.40	188.22	194.50	.	189.00	263.35	279.20	206.30	342.50	.	262.70
77.78	208.08	204.80	206.30	195.00	.	214.30	280.67	286.50	232.30	307.50	.	302.60
78.79	185.73	208.90	192.70	376.00	.	193.50	266.17	289.20	230.80	488.00	.	283.70
79.80	222.24	213.30	210.68	187.50	219.00	243.30	281.83	293.20	224.06	307.50	314.00	335.10
80.81	194.13	194.80	196.00	197.45	.	195.00	256.23	276.10	219.00	331.66	.	290.70
81.82	187.69	196.30	188.80	265.00	183.50	180.40	282.86	290.60	235.00	410.00	250.00	275.10
82.83	161.98	156.76	161.50	129.00	.	161.76	226.83	238.60	171.83	310.00	.	232.60
83.84	157.35	157.80	167.00	160.00	.	158.00	215.34	223.70	176.40	264.00	.	220.50
84.85	180.19	177.20	189.80	161.00	.	180.64	225.33	229.00	199.20	245.00	.	226.00
85.86	178.32	178.32	191.67	.	.	181.45	280.86	280.86	227.67	.	.	286.34
86.87	181.25	181.25	187.20	.	.	173.02	281.82	281.82	234.40	.	.	269.99
87.88	162.45	158.81	167.00	137.00	.	163.26	249.08	251.50	197.50	266.00	.	254.76

YEAR	SDss	SDif	SDso	SDfo	DOCss	DOCif	DOCepi	DOCso	DOCfo	DOCan
76.77	7.94	7.94	6.60	.	.	.	.	.	.	.
77.78	8.26	8.42	9.00	8.00	.	.	.	.	.	.
78.79	7.20	7.05	6.00	8.40	2.38	2.38	2.46	.	.	2.27
79.80	6.82	7.55	9.90	6.50	2.31	2.22	3.45	2.05	2.20	2.28
80.81	6.93	6.87	6.50	.	2.28	2.26	2.43	2.15	.	2.28
81.82	6.04	6.19	.	6.55	2.16	2.30	2.30	2.70	2.45	2.22
82.83	7.20	7.67	10.00	.	2.00	2.00	2.05	2.00	.	1.97
83.84	8.50	7.92	5.60	.	1.95	1.92	2.10	1.80	.	1.96
84.85	7.36	6.88	4.50	.	2.14	2.11	2.32	2.00	.	2.14
85.86	5.85	5.85	.	.	2.08	2.08	2.18	.	.	2.07
86.87	6.05	6.05	.	.	2.03	2.03	2.12	.	.	2.00
87.88	7.70	7.64	7.30	.	2.05	2.03	2.13	1.90	.	2.06

Table A29. Chlorophyll, TP, NO_3 and NH_4 concentrations in Walker Lake during 1976/77 - 1987/88.

YEAR	CHLss	CHLif	CHLso	CHLfo	CHLan	TPss	TPif	TPepi	TPso	TPfo	TPan
76.77	2.37	2.37	2.00	2.70	1.89	6.79	6.49	6.17	5.00	.	6.61
77.78	1.78	1.80	1.20	3.10	1.45	6.47	6.32	5.75	5.95	6.25	6.39
78.79	2.36	2.20	1.00	3.80	2.04	6.27	9.82	6.28	6.33	8.90	6.61
79.80	3.12	2.81	1.25	4.40	7.88	7.38	7.52	6.76	8.35	6.40	7.39
80.81	3.30	3.00	.	1.20	1.89	7.95	7.71	6.15	.	6.50	7.13
81.82	3.68	3.24	0.80	3.50	3.62	6.97	6.93	6.09	6.80	6.85	7.15
82.83	2.42	2.22	1.20	.	2.14	6.25	6.33	5.17	6.75	.	6.52
83.84	2.28	2.15	1.50	.	2.34	6.68	6.92	6.33	7.85	.	6.68
84.85	1.58	1.60	1.70	.	1.55	6.45	6.45	5.43	.	.	6.45
85.86	4.16	4.16	.	.	4.18	6.08	6.08	5.22	.	.	6.09
86.87	4.36	4.36	.	.	3.98	6.22	6.22	5.29	.	.	6.41
87.88	3.45	2.90	1.90	1.70	3.38	6.33	6.14	4.60	6.55	4.75	6.05

YEAR	NO_3ss	NO_3if	NO_3epi	NO_3so	NO_3fo	NO_3an	NH_4ss	NH_4if	NH_4epi	NH_4so	NH_4fo	NH_4an
76.77	20.16	43.70	12.80	140.00	.	31.90	19.20	20.90	11.90	.	.	34.40
77.78	15.18	35.80	12.50	80.00	40.00	53.80	36.94	33.50	20.00	32.00	23.00	40.50
78.79	37.79	82.10	26.00	152.50	20.00	62.80	33.45	24.70	29.40	27.50	42.00	37.00
79.80	13.94	42.00	11.00	117.50	20.00	38.00	22.96	27.90	9.78	27.50	53.00	24.40
80.81	31.45	31.30	33.30	.	25.00	71.30	28.41	40.30	12.00	.	.	49.70
81.82	59.34	72.50	49.00	190.00	10.00	57.40	11.52	18.40	3.00	40.00	30.00	13.70
82.83	21.43	47.10	9.80	175.00	.	40.90	18.70	15.90	5.80	2.00	.	20.00
83.84	28.23	39.50	21.60	93.00	.	36.70	13.14	16.00	8.40	30.00	.	12.90
84.85	36.46	51.20	21.20	125.00	.	36.50	24.01	22.50	8.00	15.00	.	24.00
85.86	54.54	54.54	40.00	.	.	61.59	16.52	16.52	12.00	.	.	16.97
86.87	71.46	71.46	60.40	.	.	72.91	16.99	16.99	8.00	.	.	19.57
87.88	40.14	56.39	29.00	161.00	33.00	39.99	15.09	18.92	11.60	21.00	36.00	17.44

Table A30. TON, TN, Secchi and DOC concentrations in Walker Lake during 1976/77 - 1987/88.

YEAR	TONss	TONif	TONEPI	TONso	TONfo	TONan	TNss	TNif	TNepi	TNso	TNfo	TNan
76.77	258.66	282.10	239.10	.	.	228.60	300.02	346.70	263.80	497.50	.	294.90
77.78	250.74	253.50	258.00	243.00	232.00	262.50	302.86	322.80	290.50	355.00	295.00	356.80
78.79	258.20	242.30	251.60	167.50	403.00	315.00	329.74	349.10	307.00	347.50	465.00	414.80
79.80	267.10	284.10	262.22	332.50	272.00	285.60	304.00	354.00	283.00	477.50	345.00	348.00
80.81	288.70	275.70	292.00	.	.	244.30	348.56	347.30	337.30	.	335.00	365.30
81.82	241.36	233.60	240.00	210.00	220.00	235.30	312.22	324.50	292.00	440.00	260.00	306.40
82.83	209.54	208.10	211.20	203.00	.	205.00	249.67	271.10	226.80	380.00	.	265.90
83.84	195.17	196.00	192.60	200.00	.	210.10	236.54	251.50	222.60	323.00	.	259.70
84.85	224.48	230.50	234.00	260.00	.	225.00	284.95	304.20	263.20	400.00	.	285.50
85.86	239.20	239.20	244.67	.	.	240.22	310.26	310.26	296.67	.	.	318.78
86.87	226.83	226.83	226.00	.	.	225.71	315.27	315.27	294.40	.	.	318.19
87.88	210.26	207.76	204.40	189.00	214.00	206.42	265.50	283.07	245.00	371.00	283.00	263.84

YEAR	SDss	SDif	SDso	SDfo	DOCss	DOCif	DOCepi	DOCso	DOCfo	DOCan
76.77	5.54	5.54	4.43	6.00	.	.	.	.	.	.
77.78	6.70	6.62	7.00	5.40	.	.	.	.	.	.
78.79	5.36	5.05	4.60	4.40	3.39	3.39	3.46	.	.	3.54
79.80	4.98	5.29	7.00	3.40	3.61	3.65	3.66	3.80	3.60	3.75
80.81	4.77	4.69	.	4.20	3.89	3.89	3.93	.	3.90	3.74
81.82	5.08	4.96	5.80	3.50	3.35	3.42	3.38	3.30	3.90	3.38
82.83	5.40	5.53	6.20	.	3.20	3.18	3.22	3.10	.	3.14
83.84	5.36	5.50	6.20	.	3.16	3.08	3.18	2.80	.	3.14
84.85	5.12	5.12	.	.	3.39	3.34	3.52	3.10	.	3.39
85.86	4.58	4.58	.	.	3.38	3.38	3.47	.	.	3.38
86.87	4.72	4.72	.	.	3.30	3.30	3.36	.	.	3.16
87.88	5.44	5.86	6.00	7.80	3.15	3.12	3.22	2.80	3.30	3.16